Compress

NOVEMBER 1953

PERMANENT FILE

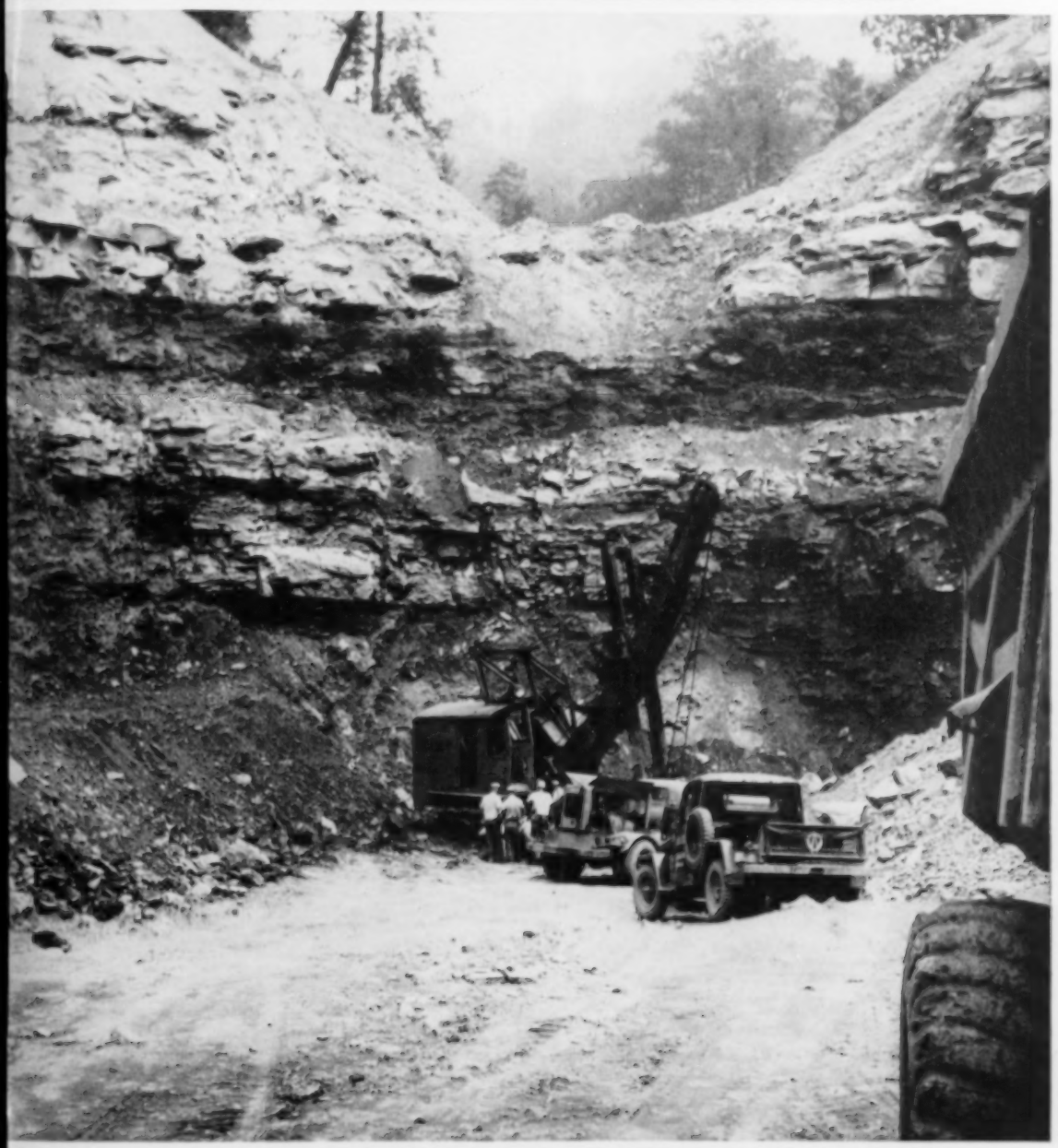
LITERATURE

Return this copy to

Advertising Division
Ingersoll-Rand
Phillipsburg, New Jersey

File _____

X-1850 2M 10-54



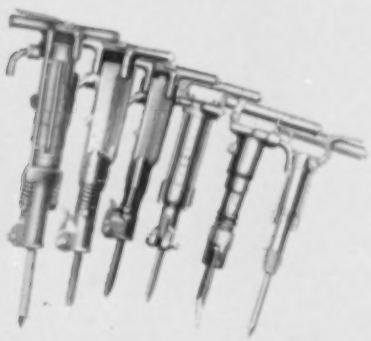
CLEARING WAY
FOR A TUNNEL

Where West Virginia Turnpike
Will Plunge Through Ridge
Between Valleys

(SEE INDEX PAGE AND PAGE 296)

VOLUME 58 • NUMBER 11 NEW YORK • LONDON

for every Ingersoll-Rand Paving Breaker



an engineered line of LONGER-LASTING TOOLS AND ACCESSORIES

Moil Points

Moil Point Blanks

Wedge Points

Narrow Chisel Bits

3-Inch Chisel Bits

2" x 12" Digging Chisels

5-Inch Asphalt Cutters

5½-Inch Clay Scoops

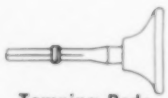
3" and 5" Flat Picks

Boulder Breakers

Broaching Steels

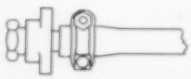
Detachable Shanks

Sheathing Drivers


Tamping Pads

2" x 12" Wedges

Curved Chisel Bits


Hose & Hose Coupling

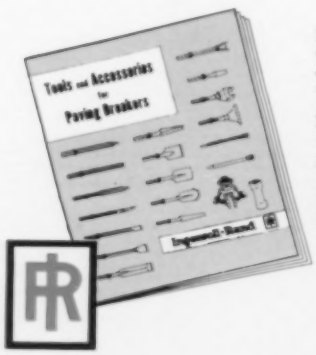
Hose Menders

IT'S THE BREAKER that supplies the power, but it's the *tool* that delivers the *work!*

That's why all Ingersoll-Rand paving breaker steels and accessories are made to the most exacting specifications. Only tool steel of the proper analysis and physical characteristics is used. Advanced production methods and controls in heat treating and inspection assure the right combination of hardness and toughness in the finished product. All accessories are tempered, ready for immediate use.

This extra care and precision pays off in longer tool life. Many users report that I-R accessories have cut their replacement costs in half!

Send for this new Bulletin on I-R Paving Breaker Accessories



Here, in one 16-page volume, you'll find complete data on all tools and accessories for use with all Ingersoll-Rand paving breakers. Ask your I-R representative for a copy — or write to Ingersoll-Rand, 11 Broadway, New York 4, N. Y.

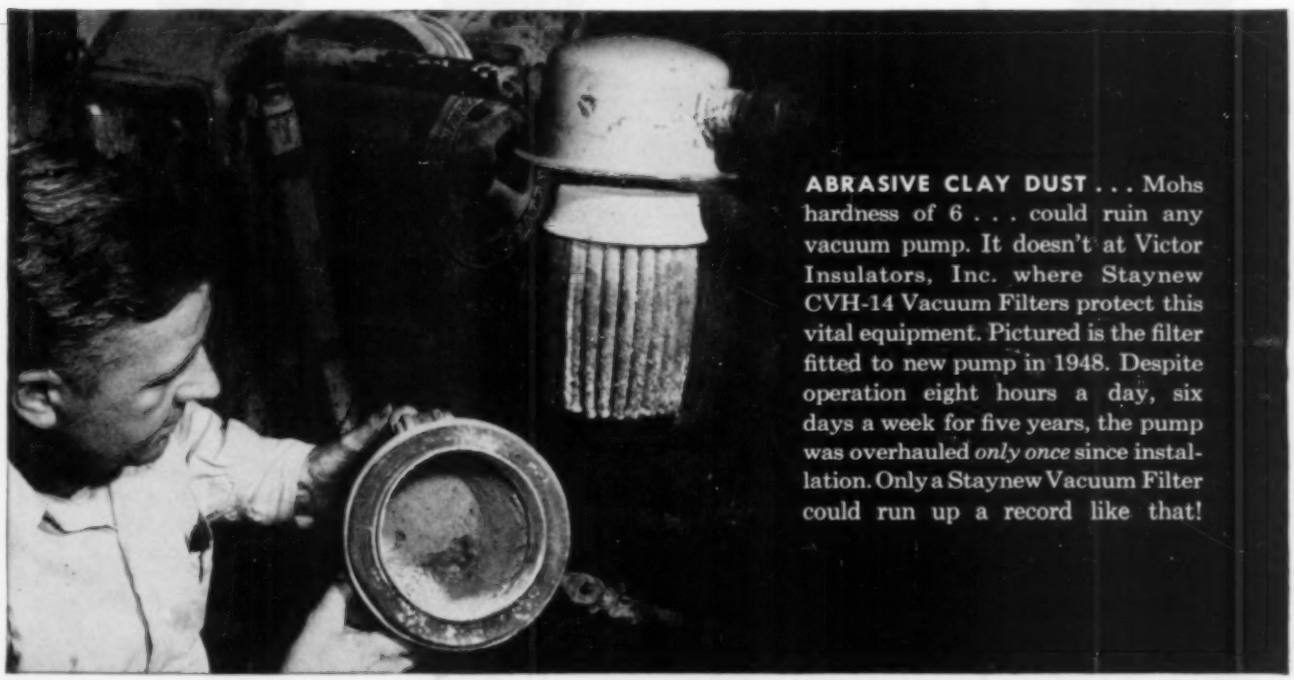
Ingersoll-Rand
11 Broadway, New York 4, N. Y.

074-15

ROCK DRILLS · AIR TOOLS · DIESEL AND GAS ENGINES · COMPRESSORS · CENTRIFUGAL PUMPS · VACUUM EQUIPMENT

"THIS STAYNEW VACUUM FILTER CUTS MAINTENANCE TIME IN HALF"

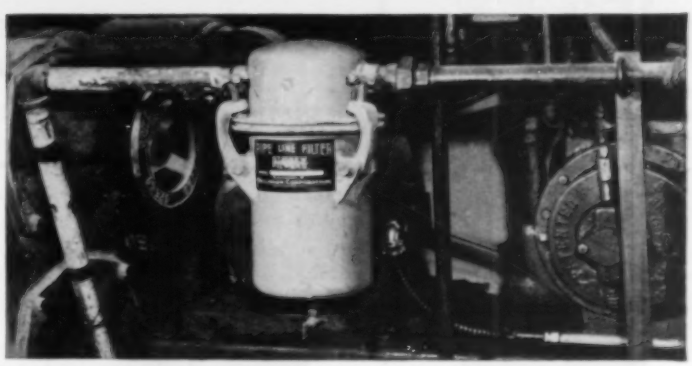
SAYS JIM McKEE
MAINTENANCE DEPT. FOREMAN
VICTOR INSULATORS, INC.



ABRASIVE CLAY DUST . . . Mohs hardness of 6 . . . could ruin any vacuum pump. It doesn't at Victor Insulators, Inc. where Staynew CVH-14 Vacuum Filters protect this vital equipment. Pictured is the filter fitted to new pump in 1948. Despite operation eight hours a day, six days a week for five years, the pump was overhauled *only once* since installation. Only a Staynew Vacuum Filter could run up a record like that!

This is one of three vacuum pumps on pug mills at Victor Insulators, Inc., drawing air from clay mix. In the process, the pumps draw clay dust back through return air lines. Without the positive protection of Staynew Vacuum Filters, these pumps would be torn down continuously for parts replacement.

You'll want Staynew Filters for your process, too. Send for Staynew Pipe Line Filter Bulletin 200.

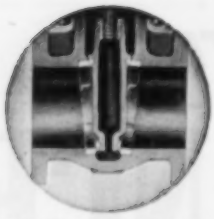


DOLLINGER PROTECTS MOTOR STAYNEW FILTERS

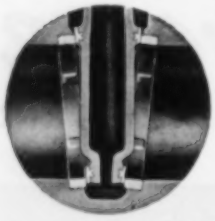
Representatives In Principal Cities

DOLLINGER CORPORATION, 7 Centre Park, Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.

Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

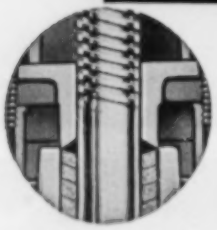
WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.



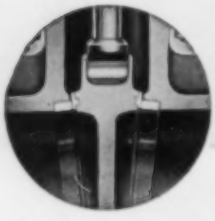
Brass Liner on Glands assures greater resistance to corrosion and scoring.

WALWORTH

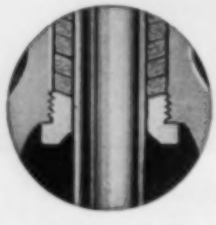
valves and fittings

60 EAST 42nd STREET NEW YORK 17, N. Y.

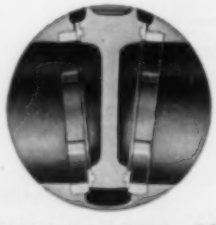
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



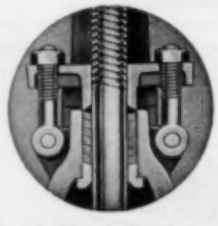
T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



Bronze Back-Seat Bushings in bonnets of OS&Y valves.



Solid Web Type Disc in OS&Y valves for greater strength and longer service.



Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

FOR ACCURATE RECORDINGS...

To obtain reliable subsurface petroleum surveys, seismic prospecting crews demand accuracy to the "nth" degree in their field equipment—and especially in their explosives and E.B. caps. Hercules has pioneered in the development of many special seismograph products, including: the Vibrogel® series...which detonate under severe water pressures; Spiralok® . . . rigid dynamite cartridge assembly that saves time in loading; and the Vibrocap® SR series... detonators that reduce the danger of premature firing by static electricity, and eliminate "time-lag" between firing and actual detonation of explosives charge. Hercules has the right types of explosives and the service facilities to expedite their use in petroleum projects, coal mining, metal mining, quarrying, and construction.

HERCULES POWDER COMPANY
INCORPORATED

Explosives Department, 932 King St., Wilmington 99, Del.

Birmingham, Ala.; Chicago, Ill.; Duluth, Minn.; Hazleton, Pa.; Joplin, Mo.; Los Angeles, Cal.; New York, N. Y.; Pittsburgh, Pa.; Salt Lake City, Utah; San Francisco, Cal.

XR53-6

NEW!

EIMCO 105's are new equipment for mining, construction, quarry, tunneling, logging, oil fields, farming or any job requiring a thoroughly tough unit as a prime mover, bulldozer, or loader.

Machines are designed, usually, for a weight limit to sell at a price OR THEY ARE DESIGNED FOR SERVICE. EIMCO machines have always been designed for service — weight and price receive no consideration. The result in this case is a unit designed to give maximum life — (3 to 4 times more than ordinary equipment in the same class) — with minimum maintenance attention. Trouble free service for many years on the job.

Construction is rugged, with each piece designed for maximum loading conditions — using the most modern metallurgical research and best in tooling and equipment. Each part is processed to give it toughness and hardness in the right places.

On the EIMCO 105 you'll find no weak spots designed to produce repair parts sales. No bulk weight spots to provide "cheap beef". Every part is functional — made of steel — fabricated, or alloy steel forgings and castings. The 105 is powered to give maximum effective use of every ounce of energy applied.

See this unit in action — operate it yourself. There is nothing like it anywhere! You'll be amazed at the easy controls, the performance — the simplicity. Write for more details.

The Eimco Corporation, manufacturers of heavy mining, construction and processing equipment and has been serving industry since 1884. With its own complete manufacturing facilities, which include iron and steel foundries, steel fabrication shops, forge and press shops, complete machine and assembly shops, laboratories, research, testing and process development departments. Eimco controls the manufacture of the product from pouring of the metal to testing of the finished product.

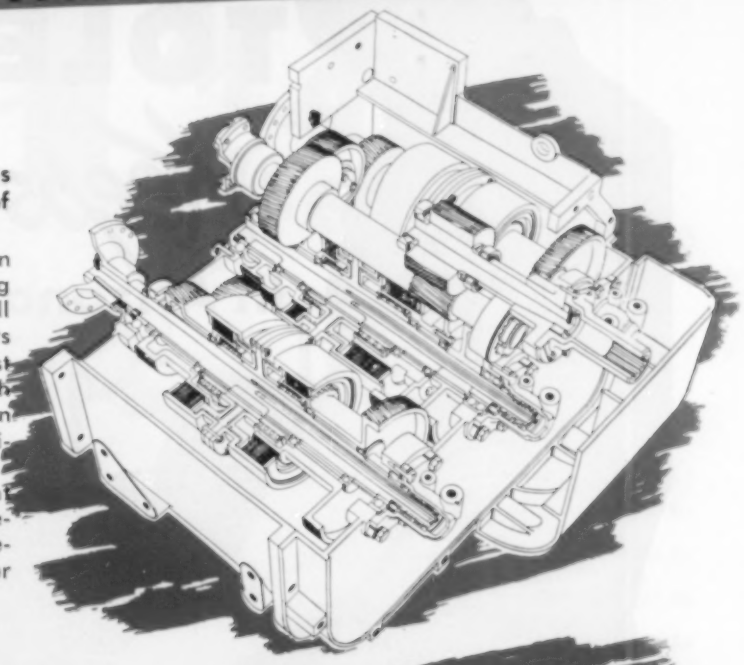
LOADER—WITH COST SAVING ADVANTAGES

NEW Eimco Transmission:

Eimco's great new Unidrive achieves supremacy in engineering advancement of tractor power transmissions.

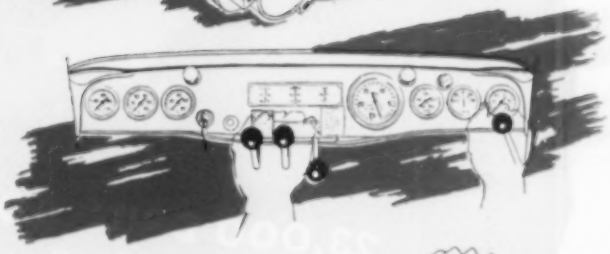
The Unidrive is a compact transmission containing in one unit all of the gearing and clutches for speed changing and full independent reversal of each tracks. Its unique design combines all of the best features of torque converter, constant mesh gearing, hydraulically actuated friction clutches and sealed oil bath, pressure lubrication of all wearing parts.

The oil-cooled, positive engagement clutches never need adjustment. The precision helical gearing is alloy steel, carefully heat-treated and micro-shaved for years of quiet operation.



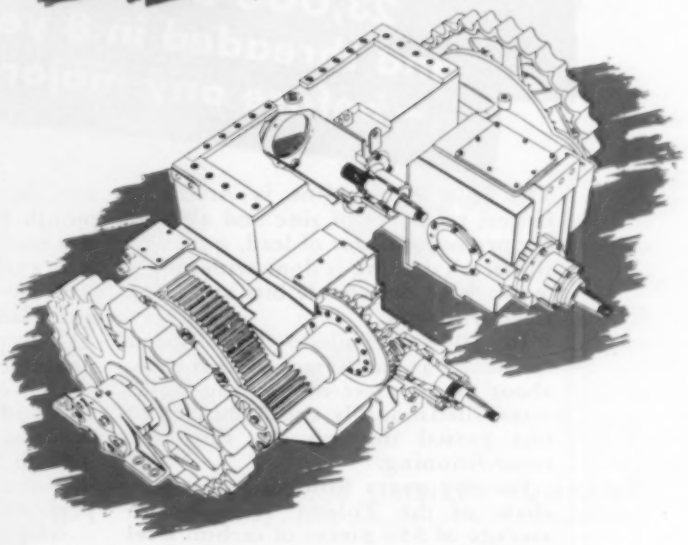
NEW Controls and Instruments:

The Eimco 105 may be operated by one hand covering two small levers. Push for forward motion, pull for reverse motion. Each lever controls the track on its respective side, a twist of the wrist starts one track in forward motion and the other in reverse for a spin turn or release one handle and it will automatically return to neutral for a gradual turn. Attachments, such as the Eimco loader can be operated by the other hand.



NEW Final Drive:

Each track is equipped with its own final drive in a cast steel case with a cast steel cover. These final drives do not house clutches or troublesome gadgets. They are sturdy heavy-duty parts carefully machined for silent operation and long service under unusually difficult job conditions.



NEW Many Other Features:

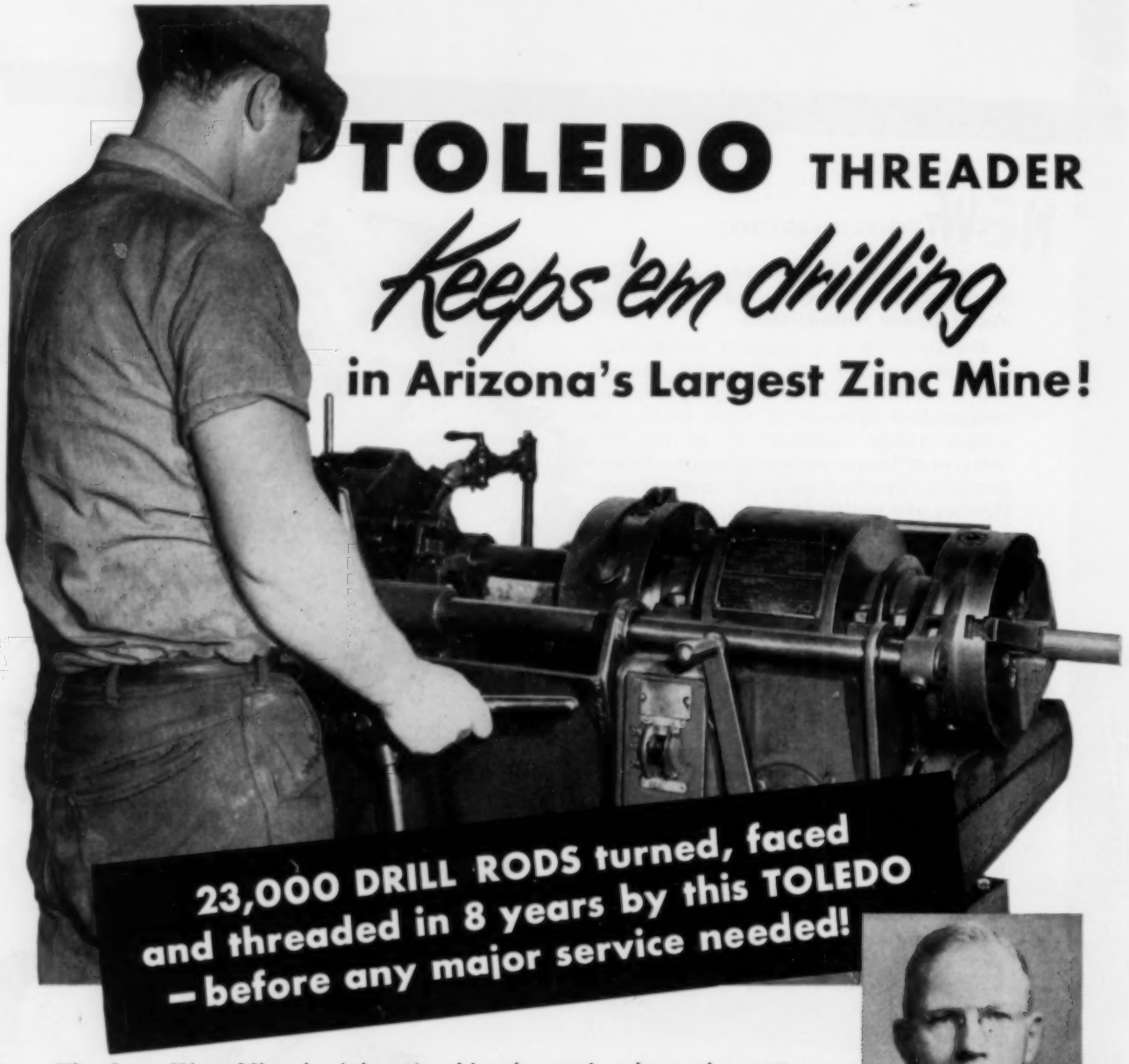
There are many other features in the 105 such as: instant reverse at all speeds, torque converter cushioned drive, air cooled precision disc brakes, all metallic clutch facings, full flow oil filters, force feed lubrication, adjustable digging depth stops, variable height discharge, 1½ to 2½ cubic yard buckets and many others.

THE EIMCO CORPORATION
Salt Lake City, Utah, U.S.A.
Export Office: Eimco Bldg., 52 South St., New York City

TOLEDO THREADER

Keeps 'em drilling

in Arizona's Largest Zinc Mine!



23,000 DRILL RODS turned, faced and threaded in 8 years by this TOLEDO — before any major service needed!

The Iron King Mine is Arizona's largest producer of zinc and also an important producer of lead, gold and silver. All drilling is done with tungsten carbide detachable bits and alloy steel drill rods.

In 1944 a Toledo high speed threader was purchased. At that time, about 30,000 feet of blasting holes was drilled monthly, and about 10,000 bits passed through the shop for reconditioning.

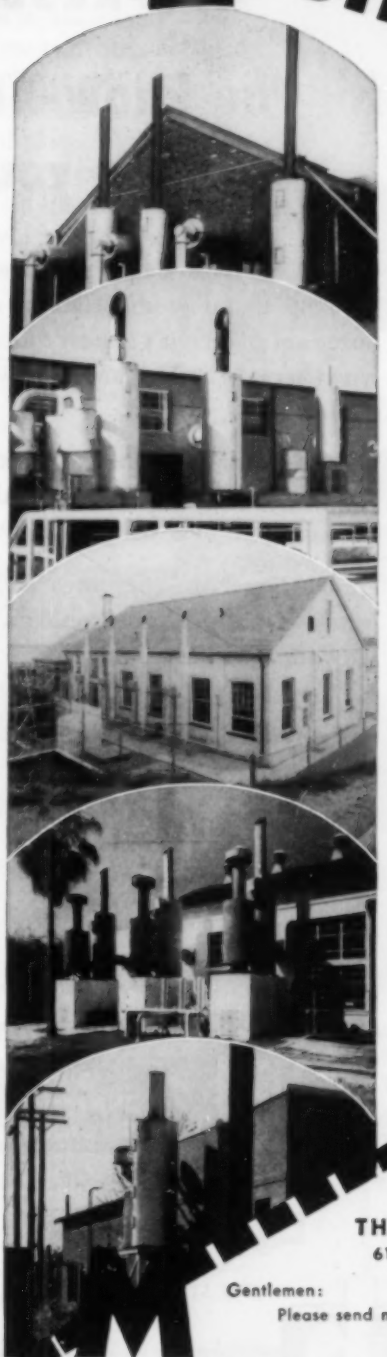
For five years following the purchase of the Toledo Threader an average of 350 pieces of carbon steel per month were turned, faced and threaded on this machine. After changing to alloy rods and tungsten bits, the number dropped to 135 per month, but the duty of reconditioning this steel was much more severe than with carbon steel rods. No major repair or replacement was necessary until late in 1951, after more than 23,000 pieces of steel drill had been processed by this machine.

You, too, can save time and reduce costs with a TOLEDO Rock Drill Rod Machine! After rod is annealed, the Toledo Machine will turn to size, thread and face off end of rod to a perfect fit for detachable bits. Rugged ... simple ... dependable. Send for bulletin 45. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

"We are entirely satisfied with outstanding performance and service the TOLEDO Threader has given us," says H. F. Mills, General Mgr. of The Iron King Mine at Humboldt, Arizona.

RELY ON THE LEADER TOLEDO FOR ROCK DRILL ROD MACHINES

YOU'RE ALWAYS A GOOD NEIGHBOR---- WITH MAXIM SILENCERS



When horsepower has to work 24 hours a day in close proximity to residential and business areas, the best exhaust silencing you can get is just downright necessary.

That is one very good reason why public relations-conscious municipal plants from coast to coast choose Maxim Silencers.

Maxim Silencers are backed by longer manufacturing experience, more field use, and the broadest engineering and research background in acoustics available.

Because silencing needs vary so greatly, good engineering advice to start with is almost as important as the product. Maxim engineers know municipal plant problems, and can be of real assistance in planning efficient installations. They are at your service.

Consult **MAXIM**

THE MAXIM SILENCER COMPANY
61 Homestead Ave., Hartford 1, Connecticut

Gentlemen:
Please send me your bulletins on Exhaust and Intake Silencers.

NAME_____

COMPANY_____

ADDRESS_____

_____

19MX53

To Avoid Fluid Line Troubles

DEPEND UPON THE HANSEN REPRESENTATIVE

for the know-how you need... when you need it

H. U. ROGNESS
H. U. Rogness, Inc., Minneapolis
Offers many years of experience in servicing and specifying equipment for hydraulic and pneumatic lines in plants of manufacturers, foundries, food processors and other industrial firms.

ELLIS AKIN
Ellis Akin Engineering Co.
Kansas City, Missouri
Provides specialized engineering service on pneumatic and hydraulic lines in the Kansas, Nebraska, Western Iowa and Western Missouri area.

MALCOLM B. STURGIS
Sturgis Equipment Co., St. Louis
Serves widely diversified group of industries on problems related to pneumatic and hydraulic equipment, including filters, regulators, lubricators and quick-connective couplings.

When you need help—and need it in a hurry—it will really pay you to know the Hansen representative in your area. In dozens of plants, it's almost routine procedure to call him—either when actual troubles arise—or when fluid line circuits are being planned or altered.

From his years of experience with almost every type of hook-up, he can tell you what works—and why it does. Frequently he can make suggestions which will quickly clear up your difficulties.

Quick-connective couplings are, of course, his main business—but so are fluid line problems. Make use of his know-how—it's yours for the asking.

REPRESENTATIVES

BALTIMORE	DETROIT	NEWARK
BIRMINGHAM	FT. WAYNE	NEW ORLEANS
BUFFALO	HARTFORD	PHILADELPHIA
CHICAGO	KANSAS CITY	PITTSBURGH
CLEVELAND	LOS ANGELES	SAN FRANCISCO
DALLAS	LOUISVILLE	SAVANNAH
DAYTON	MILWAUKEE	SEATTLE
DENVER	MINNEAPOLIS	ST. LOUIS

MONTREAL • TORONTO • VANCOUVER
Export Department: Cleveland

QUICK-CONNECTIVE FLUID LINE COUPLINGS

1. QUICK CONNECTION AND DISCONNECTION
2. INSTANT AUTOMATIC FLOW OR SHUT-OFF

One-Way Shut-Off

Two-Way Shut-Off

ALSO STRAIGHT-THROUGH QUICK-CONNECTIVE COUPLINGS

Send for Catalog!

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

Air Casualties

It's bad air that does it. But you can step up production by putting a Coppus Blower on the job to keep the air moving — and keep the men cool.

The kind of air a man works in has a lot to do with how much work he can turn out.

In confined places like shipholds or tanks or drums or boilers . . . or wherever the air is stagnant or hot or full of fumes . . . a Coppus Blower is a *must* for getting first-class work out of the men, all the time.

A Coppus Blower or Exhauster helps avoid sickness and lassitude due to bad air . . . and improves morale, too.

Portable and adaptable for special purposes, Coppus Blowers and Exhausters will have dozens of uses around your plant. The "Blue Ribbon" (a blue painted band) is your assurance of quality performance at lowest cost.

COPPUS

BLUE RIBBON BLOWERS

THE BLOWERS THAT PUT MORE MINUTES IN EVERY MAN-HOUR

CABLE MANHOLE AND TANK VENTILATORS — BOILER MANHOLE BLOWERS AND EXHAUSTERS — HEAT KILLERS — SHIPHOLD VENTILATORS . . . DESIGNED FOR YOUR INDUSTRY — ENGINEERED FOR YOU

MAIL THIS COUPON To Coppus Engineering Corp., 211 Park Avenue, Worcester 2, Mass. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in BEST'S SAFETY DIRECTORY.

PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets, etc., after treated with coating material.

NAME .....

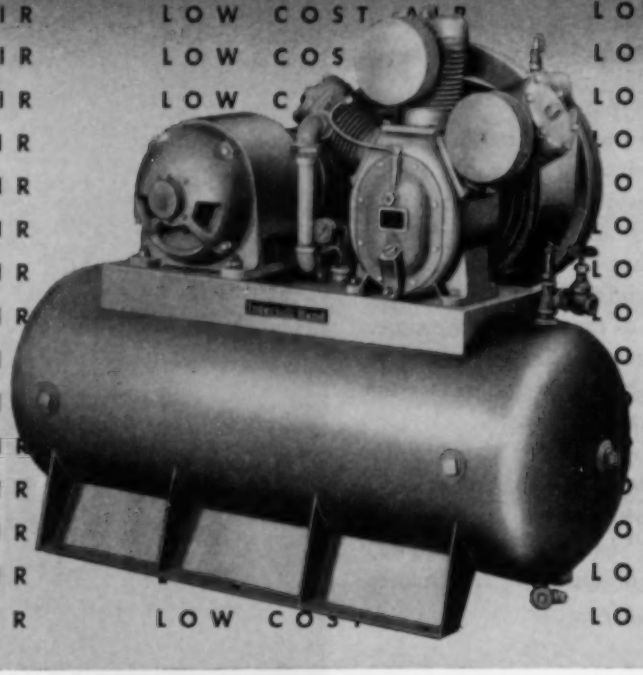
COMPANY .....

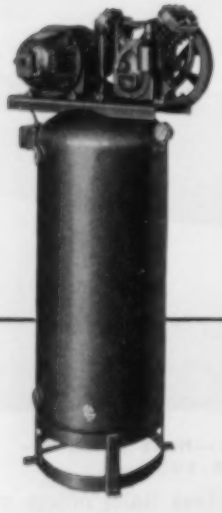
ADDRESS .....

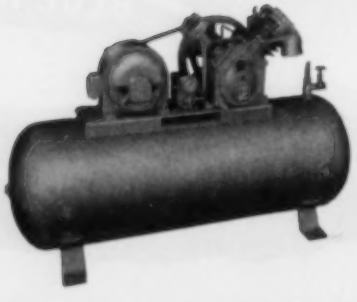
CITY .....

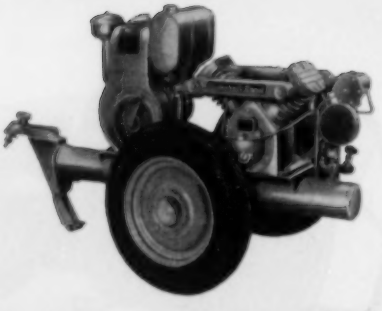
(Write here any special ventilating problem you may have.)

LOW COST AIR









- Exclusive Ingersoll-Rand features provide lowest cost compressed air.
- High efficiency and low maintenance costs of Ingersoll-Rand compressors helps pay for the unit out of operation savings.
- A type and size for every automotive service requirement.
- See your nearest Ingersoll-Rand Distributor or write for Bulletin 1500-C.

SIZES: ½ to 15 hp—a type for every requirement.

PRESSURES: To meet all automotive needs.

MOUNTINGS: Complete Receiver; Base Plate; Bare Compressor; High Speed Trailer; Caster Mounted or Steel Wheel Mounted.

CONTROLS: Automatic Start and Stop; Constant Speed; Dual (combination automatic start-stop and constant speed).

939-3

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

. . . *the mark of an outstanding motor*

The familiar L. A. that identifies each motor built by The Louis Allis Co. is more than a mere trademark. These two distinctive strokes formed the signed initials of Louis Allis—our founder and first president. He used them to signify approval on the many matters that crossed his desk each day.

To us these initials on our product symbolize a challenge—a challenge to continue building our motors to the high standards of quality and performance established by Louis Allis more than 50 years ago. To you they mean sound design, rugged construction, and ample safety factor for long life and dependability—all the things you want in electric motors.

You can't go wrong when the motor for *your* job carries the famous L. A. Trade-mark. Always look for it.

IN101

THE LOUIS ALLIS CO. MILWAUKEE 7, WISCONSIN

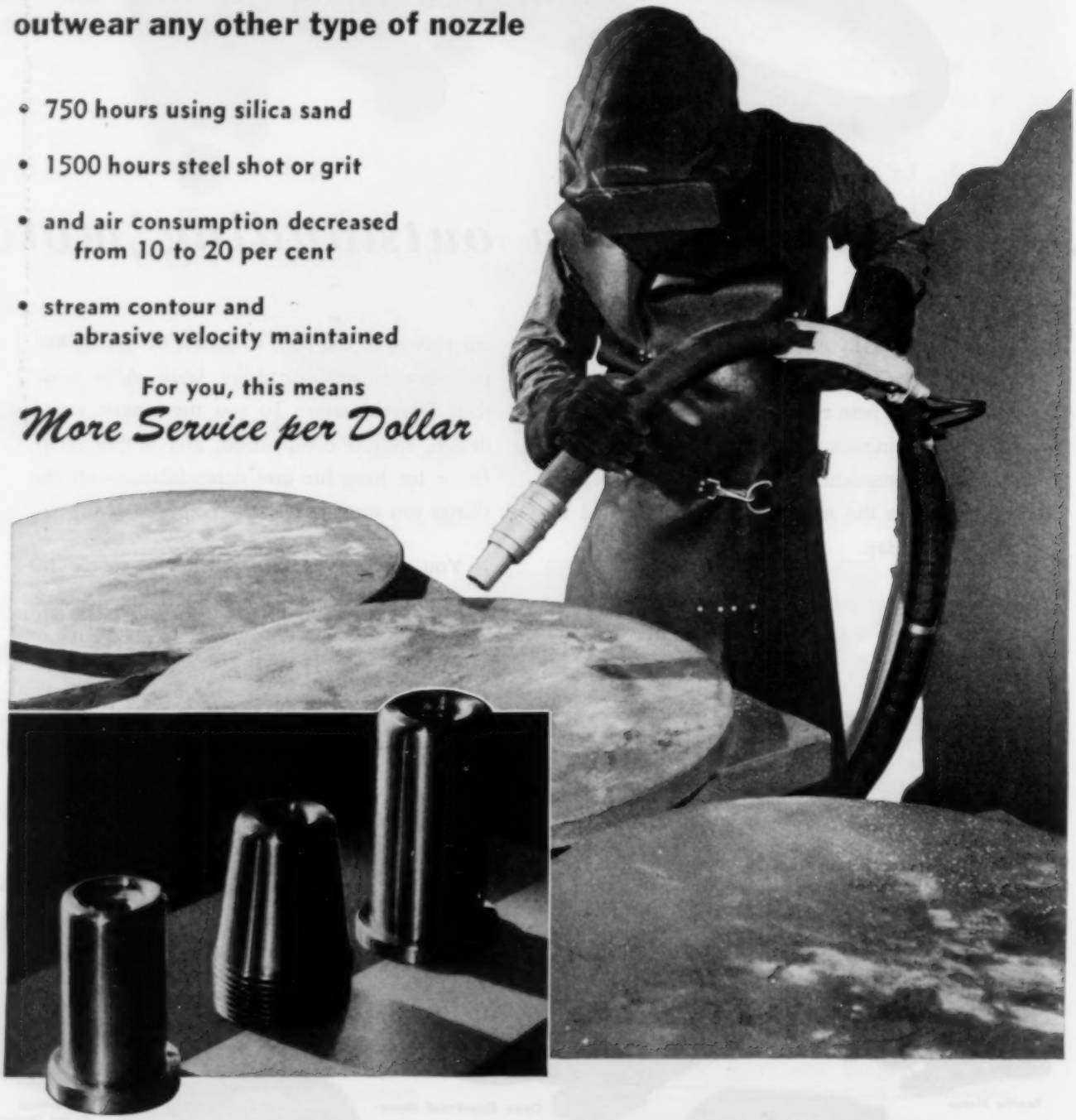
Hundreds of hours longer...

NORBIDE® Pressure Blast Nozzles
outwear any other type of nozzle

- 750 hours using silica sand
- 1500 hours steel shot or grit
- and air consumption decreased from 10 to 20 per cent
- stream contour and abrasive velocity maintained

For you, this means

More Service per Dollar



Only the diamond is harder than Norbide

NORTON®

NORTON COMPANY

WORCESTER 6, MASSACHUSETTS

Making better products to make other products better

ON THE COVER

A FEW months ago and half a mile away, crews of the contracting firm of Bates & Rogers started driving a 30-foot-diameter tunnel towards the point shown on our cover. Meanwhile, Nello L. Teer, grading contractor on the stretch of roadway leading into the bore from the north, was working up Cabin Creek. At the end of his contract section he left the sheer rock face pictured, ready for the tunnel to emerge—which it did on October 2 right where it was supposed to appear. On each side of the site shown are high rock slopes. Less than a year from now motorists will speed through the cut and into the tunnel, with scarcely a thought of the thousands of man-hours of labor and hundreds of horsepower of equipment that joined forces to lay down the smooth ribbon of concrete on which they travel.

IN THIS ISSUE

THE first settlers found American rivers adequate to meet their meager transportation needs, but by the time the republic was founded, highways were much in the public mind and they have never been out of it since. Then the Government was at first unable to finance the building of roads to connect the scattered communities and, consequently, granted charters to private companies to construct them for toll operation. History is now repeating itself, and the toll road is back and proving to be extremely popular. Our leading article previews the West Virginia Turnpike, which is scheduled to go into service next summer.

•

AMONG the larger nonferrous mining operations is the tin-yielding open-pit property of Geomines deep in the Continent of Africa. Page 306.

•

WHERE conditions are favorable, industrial plants cool water for process purposes economically by means of a steam-jet water-vapor refrigeration system. Such a unit is dependable and costs remarkably little for maintenance. Oftentimes, also, the equipment can be set up in the open, thus eliminating the expense of housing. That was the case at the Cumberland, Md., plant of Kelly-Springfield Tire Company. Page 309.

Compressed Air Magazine

COPYRIGHT 1953 BY COMPRESSED AIR MAGAZINE COMPANY

VOLUME 58 **November, 1953** NUMBER 11

G. W. MORRISON, *Publisher*
C. H. VIVIAN, *Editor* J. W. YOUNG, *Director of Advertising*
ANNA M. HOFFMANN, *Associate Editor* J. J. KATARBA, *Business Mgr.*
J. C. PIERCE, *Assistant Editor* FRANCIS HARTMAN, *Circulation Mgr.*
A. W. LOOMIS, *Assistant Editor* WILLIAM HEINS, *Foreign Circulation Mgr.*
D. Y. MARSHALL, Europe, 243 Upper Thames St., London, E. C. 4.
F. A. MCLEAN, Canada, New Birks Building, Montreal, Quebec.

EDITORIAL CONTENTS

Mountain Boulevard—*C.H. Vivian* 296
Tin Mine in the Congo—*Andre Leenders* 306
Outdoor Water-vapor Refrigeration System—*L.B. Walker* 309
Pattie and the Apaches—*Veda N. Conner* 312
When Time Stood Still 313
Giving Motor Cars the Third Degree 314
Kemano Rodeo Drillers Compete for Cash 315
Precast Pier Caissons Sunk in River 316
Editorials—Tales of Edison—The Great Transformer 317
Concrete Blown Quarter Mile Underground 318
Inflatable Shaft for Paper Rolls 318
Industrial Notes 319
Clinchfield Railroad Washes Its Tunnels 323
Quotes from Here and There 325
Industrial Literature 328

ADVERTISING CONTENTS

Allis Co., The Louis 13
Bethlehem Steel Company 15
Compressed Air Magazine Co. 28
Cook Mfg. Co., Inc., C. Lee 18
Coppus Engineering Corp. 11
Crucible Steel Co. of America 29
Dollinger Corporation 3
Eimco Corporation, The 6, 7, 27
Elliott Company ..... 3rd Cover
Galland-Henning Mfg. Co. 28
Goodall Rubber Company 31
Grinnell Company, Inc. 25
Hansen Mfg. Co., The 10
Hercules Powder Company 5
Ingersoll-Rand Company ..... 2nd Cover, 12, 24, 32
Maxim Silencer Co., The 9
Naylor Pipe Company 19
New Jersey Meter Company 31
Niagara Blower Company 21
Nicholson & Company, W. H. 28
Norton Company 14
Nugent & Co., Inc., Wm. W. 20
Reliance Electric & Engr. Co. 26
Sarco Company 30
Sauerman Bros., Inc. 23
Schraders' Sons, A. 33
Square D Company 18
Texas Company ..... Back Cover
Toledo Pipe Threading Machine Co., The 8
Victaulic Co. of America 22
Vogt Machine Co., Henry 17
Walworth Company 4
Wisconsin Motor Corporation 16

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA **Member Controlled Circulation Audit**

Published by Compressed Air Magazine Co., G. W. MORRISON, *President*; C. H. VIVIAN, *Vice-President*; A. W. LOOMIS, *Vice-President*; J. W. YOUNG, *Secretary-Treasurer*.
Editorial, advertising, and publication offices, Phillipsburg, N. J.
New York City Office, 11 Broadway. L. H. GEYER, *Representative*.
Annual subscription: U.S., $3.00, foreign, $3.50. Single copies, 35 cents.
COMPRESSED AIR MAGAZINE is on file in many libraries and is indexed in Industrial Arts Index and in Engineering Index.

West Virginia Joins the Turnpike Parade with a

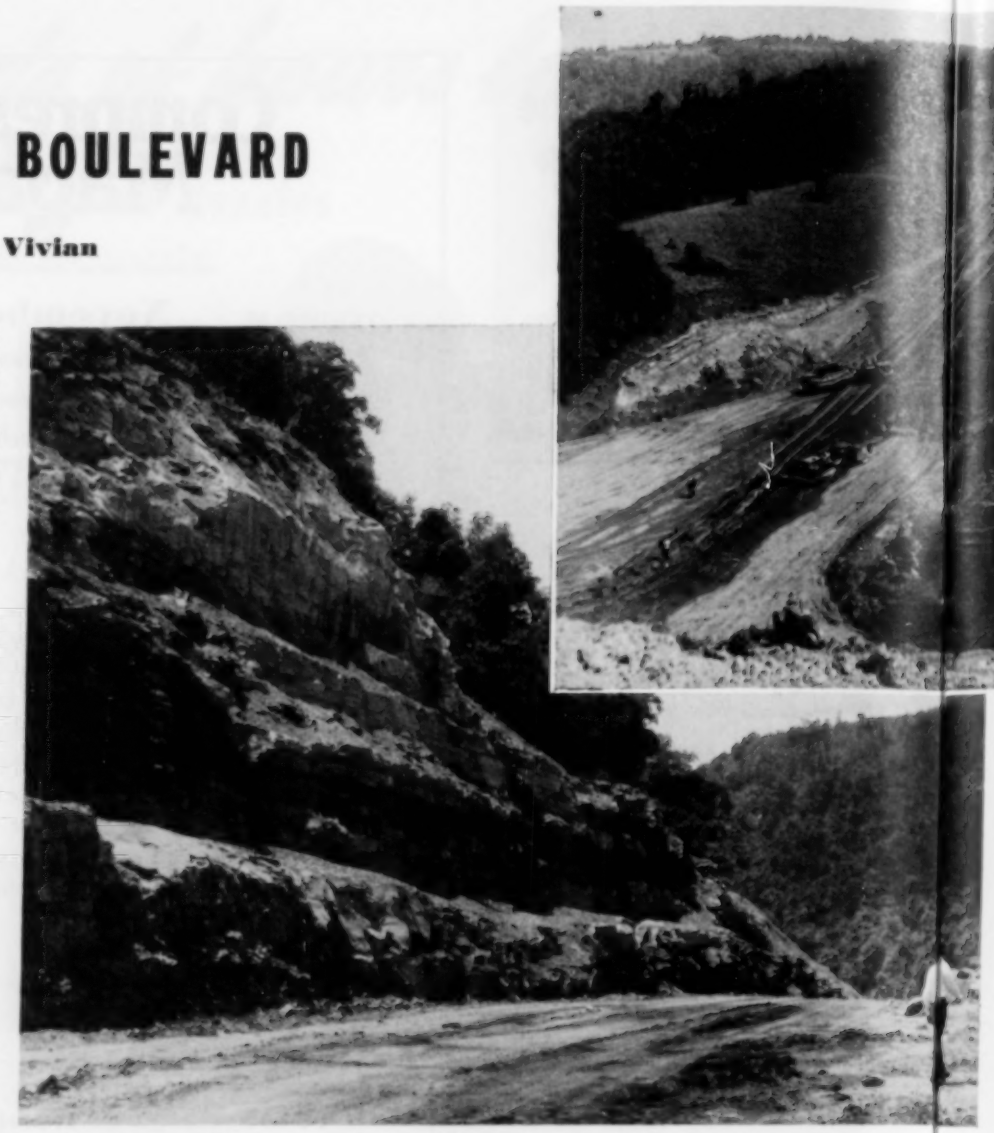
MOUNTAIN BOULEVARD

C. H. Vivian

IN ITS assiduous search for ways to relieve the continually worsening congestion of our highways, the nation is turning to toll roads in a big way. A recent roundup shows 900 miles of them in service in nine states, 1000 more miles under construction and 400 additional miles approved for building. Still others are being proposed, studied or considered.

The toll road is, of course, an old device in a a new guise. Our first colonial pay-as-you-ride thoroughfares were built for profit purposes by private interests, and the none-too-rich young government was grateful for the outside assistance. Competition from railroads eventually put the toll collectors out of business, and roadbuilding thereafter came to be looked upon as a governmental function. It is still so considered, but local, state and federal agencies have been unable to keep pace with the demands imposed by the staggering rise in motor vehicle traffic.

More than 54 million cars and trucks are now registered, an increase of 24 million since 1944. They travel more than 500 billion miles annually. To keep abreast of their needs, the nation would have to spend around $3 billion per year on highway modernization. It hasn't been and isn't doing this, and traffic tie-ups have been steadily growing more serious. The dilemma has brought back the toll road, but this time it has quasi-public financial backing.



TERRACED CUT

Many steeply sloping rock cuts have been excavated with their faces forming a series of benches or steps as shown here. These horizontal shelves will catch and hold material that may become loosened and fall from above. Also, it has been found that by following this scheme the rock slope will, in a few years, become stabilized. It will then be possible, if desired, to remove the bottom bench in case it is decided to widen the roadway.

Pennsylvania led the modern movement for these high-speed highways that by-pass urban communities and eschew grade crossings and traffic lights. The nucleus of its present 327-mile route was a 160-mile east-west section in the center of the state opened in 1940. A 100-mile eastern extension was opened in 1950 and a 67-mile western addition in 1951. In the year preceding last June, 11.3 million passenger cars and trucks traveled it. The 118-mile New Jersey Turnpike, opened in 1951, has lately been averaging 55,000 vehicles a day, a mark its planners didn't expect it to reach until 1971. As many as 93,000 tolls have been collected on a single Saturday. A 15-mile toll highway in New Hampshire is doing better than was anticipated. Similar reports come from Oklahoma's 88-mile Turner Turnpike between Tulsa and Oklahoma City and a 17-mile link between Denver and Boulder in Colorado. A stretch in Maine has been so successful that it is to be extended. Strange to relate, the 17-mile Buccaneer Trail in Florida failed to meet operating expenses in 1952, possibly because the free roads are so easy to drive that there is little incentive to pay a toll.

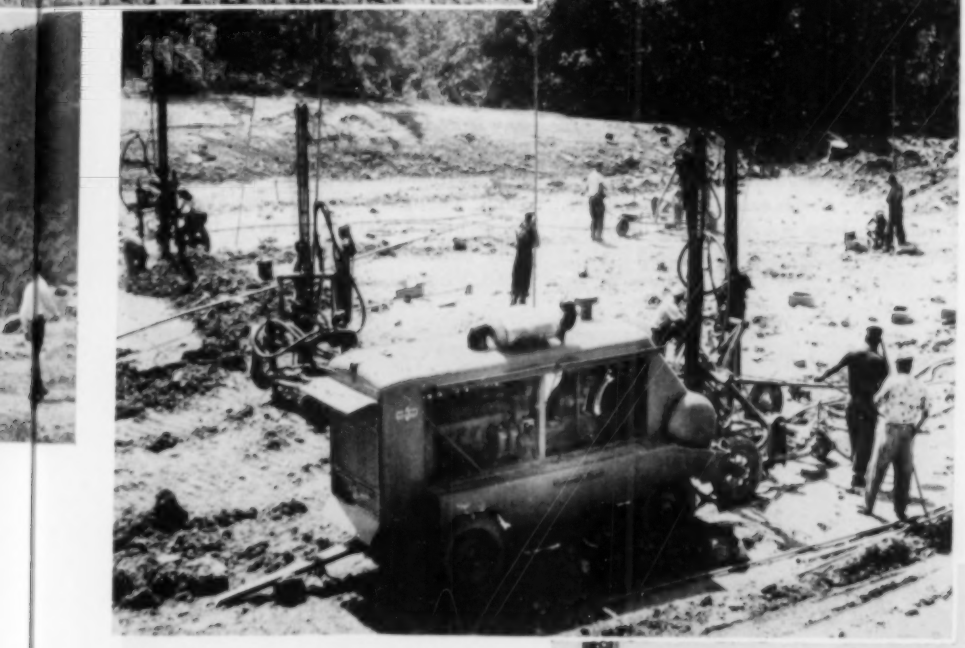
Under construction now are the New York Thruway, a $500-million, 427-mile route; the $285-million, 165-mile Garden State Parkway in New Jersey; a $326-million, 241-mile stretch in Ohio that will connect with the western end of the

Born Too Soon

Some years ago when modern roadbuilding was just getting a good start, a roving rock-drill salesman was observed to be spending a great deal of his time in West Virginia. When someone in his company asked him why he did this, he replied that he liked the state because it contained so much rock that had not been drilled. Had he lived until now, this hard-rock man would be in his glory, for they're putting a lot of blast holes in those West Virginia rocks to cleave an 88-mile path through the mountains for the West Virginia Turnpike. More than twenty contracting firms, including some of the biggest in the business, are shifting approximately 28 million cubic yards of the earth's crust from high spots to lower ones and it is estimated that about 40 percent of it is rock.

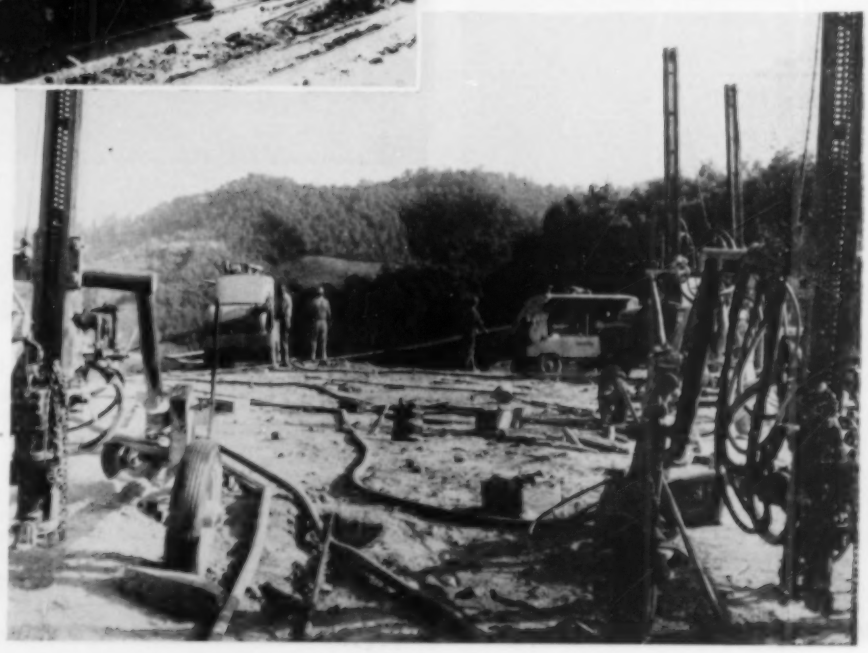
PATTERNS IN THE EARTH

In the center background of the view at the left a cut is in the making and the earth removed from it is being deposited to build a fill at the lower left. This view was on the Condon, Cunningham & Kiewit job towards the southern end of the line at a location where rock does not come to the surface. In the picture are many large pieces of earth-shifting equipment and two rollers.



WAGON-DRILL BRIGADES

Two groups of Ingersoll-Rand FM-3 wagon drills, the one below on the W.E. Graham contract, and the other on the Clark-Farrell-N.H. Rodgers & Sons job. Holes are usually spaced 6 feet apart and drilled 18 feet deep. Approximately $2 million worth of compressors, rock drills and accessory equipment was in service during the summer.



now flows through West Virginia, but will also probably attract some travel that is now by-passing that state because of its comparative lack of easy-to-drive highways. For instance, much of the passenger-car travel between the Great Lakes section and Florida now shuns West Virginia.

Building the pike is a bid by West Virginia to maintain or improve its position as a key industrial state, despite a topography that is so discouraging to road building that the ownership of automobiles per capita is well below the national average. For, even though its mountainous terrain is a bit forbidding, West Virginia is strategically located as regards markets and has abundant natural resources. It is in about the center of the region east of the Mississippi River and a circle of 500-mile radius inscribed from its center would enclose half the nation's population and half of its hundred largest cities.

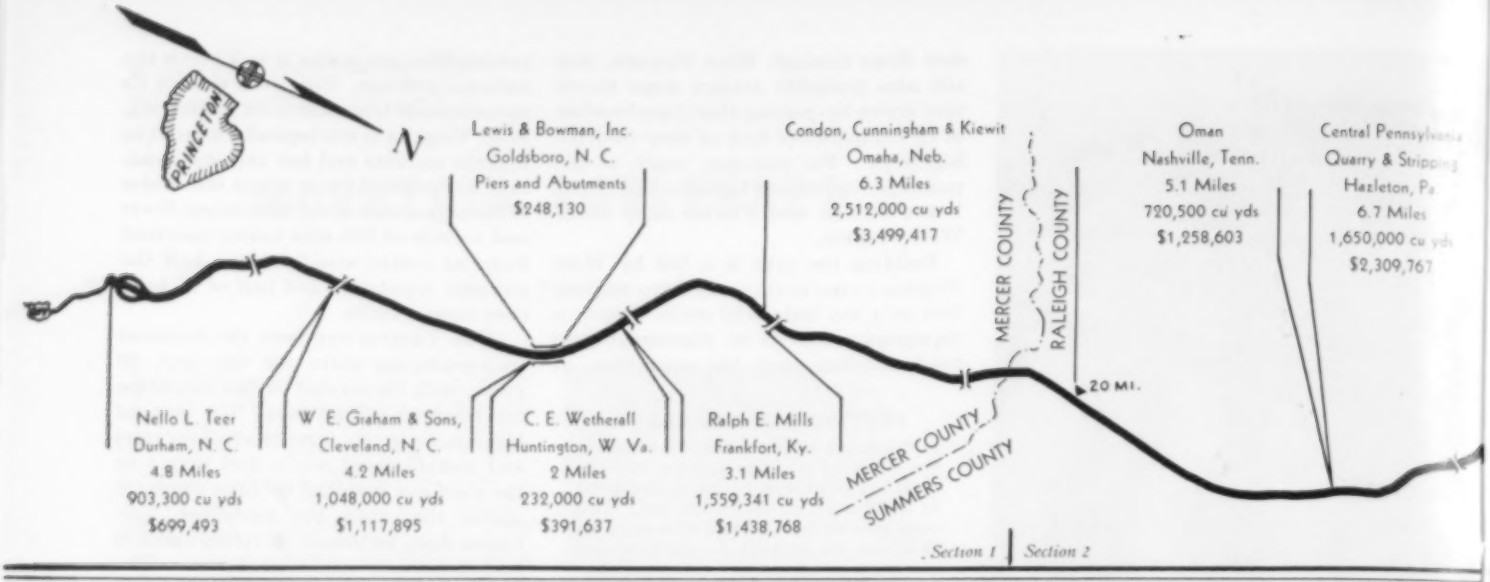
West Virginia has been the foremost coal-producing state for the past 20 years, with the annual output exceeding one-hundred million tons. The coal, of bituminous grade, furnishes fuel for steel and metallurgical works and serves as the chief raw material for huge chemical plants that turn out medicines, perfumes, dyes, fertilizers, flavoring extracts and numerous other products. The wealth of coal also insures low-cost electric power, which is attractive to industry. In other fuels, West Virginia stands first among eastern states, fifth among all states in the production of natural gas and yields about three million barrels per year of Pennsylvania-grade crude oil.

Almost inexhaustible supplies of salt and brines are used to produce table salt, chlorine, soda ash, caustic soda and pharmaceuticals. Limestone, clay, shale and silica sand pure enough for glass-making are also present. Ten million acres of forest land, mostly in hardwoods, furnish props for the coal mines and support 1800 sawmills. The state

Pennsylvania Turnpike; and a $96-million, 88-mile link in West Virginia.

It is with the one mentioned last that we are concerned. Known as the West Virginia Turnpike, it will extend southward from Charleston, the state capital, to Princeton, which is within 10 miles of the Virginia boundary. There will be interchanges at the two ends and at four intermediate points. Construction, commenced about 14 months ago, is proceeding substantially on time and is expected to be completed next summer.

The highly scenic travelway will cross three major bridges, two of them of exceptional height, and will include 81 smaller bridges. It will also plunge through a tunnel more than half a mile long. The pike will not only provide better facilities for handling the traffic that



ROUTE OF THE TURNPIKE

with salient facts regarding the primary contracts for grading, placing of piers and abutments for three major bridges and the driving of a half-mile tunnel—an aggregate of $45 million worth of work. These operations are all nearing completion, paving contracts have been let and if normal winter weather prevails the 88-mile expressway will be opened to traffic next summer.

has 98,000 farms, most of them small.

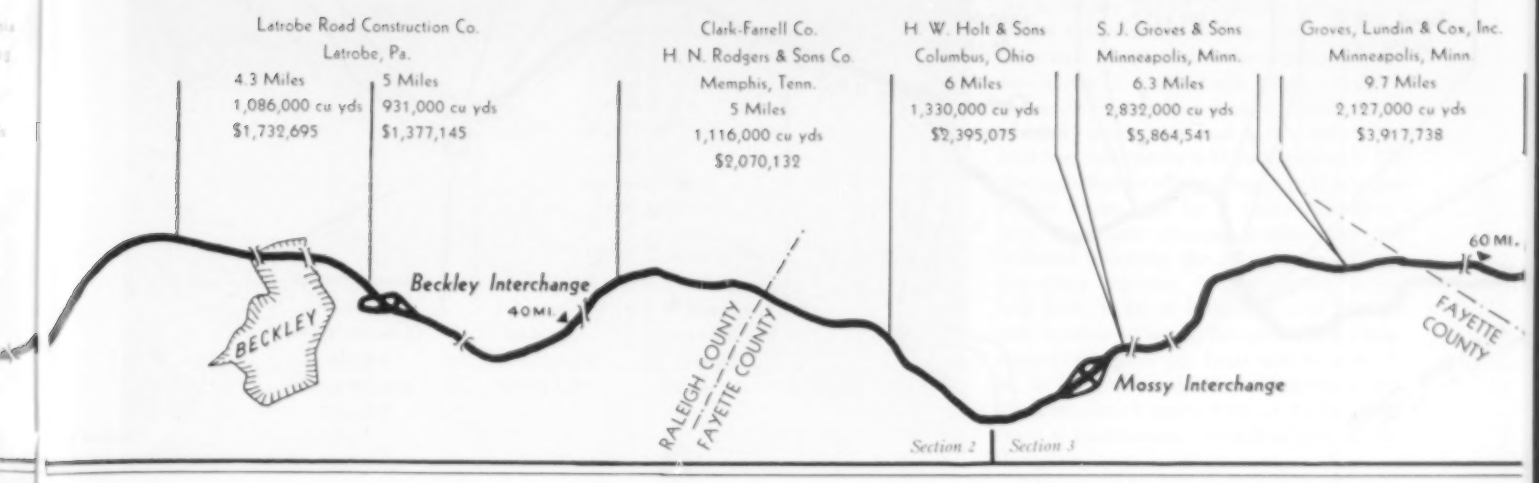
Such resources, if augmented by good transportation facilities, augur prosperity. Rail and water transport systems are already adequate. Seven rail lines that may be classed as important enter the state and there are also 23 smaller ones. The navigable Ohio River borders the state on the north and west for 273 miles. The Monongahela provides a water route for shipping coal northward to the Pittsburgh, Pa., industrial area. The Kanawha, Little Kanawha and Big Sandy form direct navigation connections with the Ohio and Mississippi River networks. The Kanawha has been canalized with low dams and locks to a point 30 miles above Charleston.

To supplement these arteries of commerce, a good road system is of course desirable. Existing highways consist of 4890 miles of primary and 27,716 miles of secondary rating. Among them are only two east-west through routes that approach modern standards and there is no modern north-south thoroughfare. Moreover, there is a deficiency of north-south railway lines for handling freight that is heavy and will continue to increase. There is a vast interchange of goods between the agricultural South and the industrial North. Motor travel is heavy, especially when the sunny warmth of the Southland beckons. Governors of the states concerned have already conferred several times regarding a possible toll turnpike to run all the way from Illinois to Florida, and one will likely be built within the next decade.

When first completed, the West Virginia Turnpike will be isolated from other high-speed travelways, but probably not for long. To the southward, both Virginia and North Carolina are

AIR PLANTS ON WHEELS

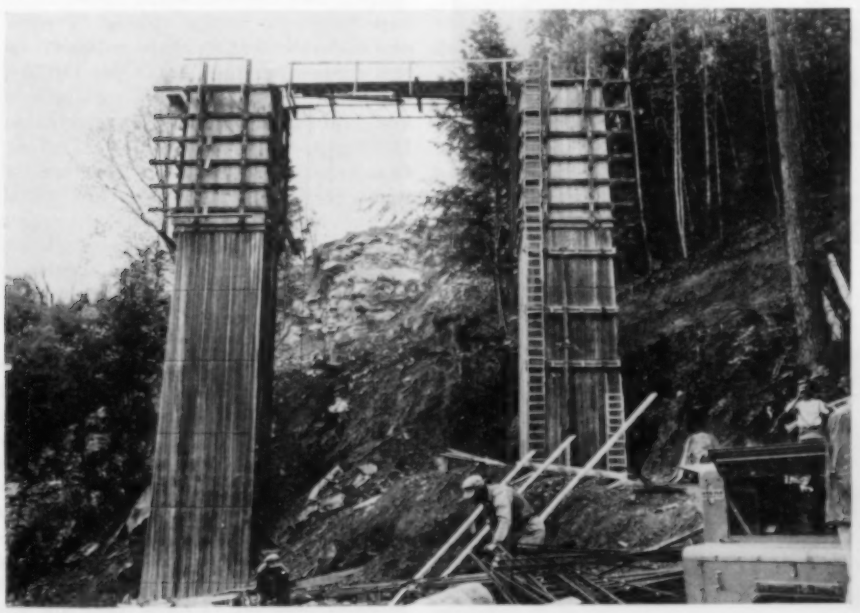
Almost every contractor uses at least one Ingersoll-Rand Gyro-Flo portable rotary compressor, with the number ranging upward to a high of fourteen for one firm. Their principal chore is furnishing air for the batteries of wagon drills. In many instances, four of them are manifolded together as shown here, and it is not uncommon for such a group to run ten drills. The machines shown belong to S.J. Groves & Sons (above) and Condon, Cunningham & Kiewit. One of the units used by the latter concern had the unusual experience of being blown into the air when lightning prematurely detonated a blast in an area within which the compressor was standing. It landed topside down, but was functionally none the worse for the jolt.



turnpike-minded and are expected to become more so after the new highway begins funneling increased traffic toward their borders. On the north, a 180-mile link, over terrain that is not nearly so rugged as that now being crossed, would form a connection with the Pennsylvania Turnpike at Somerset and on to New Jersey, New York and the New England states. West Virginians already take it for granted that this stretch will be built perhaps within the next five or ten years.

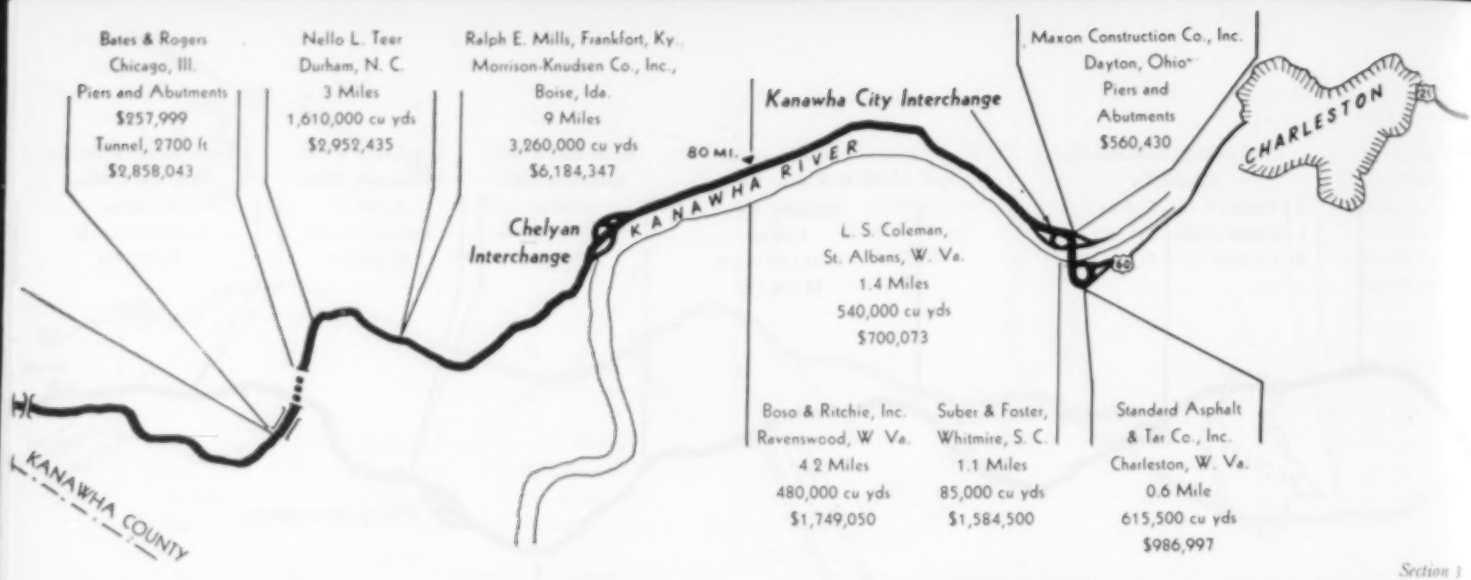
The turnpike idea cropped up when West Virginia realized that it was futile to attempt to finance a major highway with the available state funds. It took form when the state legislature created a turnpike commission of five members in March, 1947. The commission's first step was to arrange with Bear, Stearns & Company and Byrne & Phelps, Inc., both of New York, for financing the project and the second one was to retain a firm of engineers to study and report upon the feasibility of the scheme. This investigation was conducted by the New York firm of Howard, Needles, Tammen & Bergendoff, which was consultant on the New Jersey, Colorado and First Maine turnpikes and is now serving in a similar capacity on the extension in Maine. The report, rendered on November 1, 1951, after 16 months of study and including a detailed estimate of projected traffic and revenue prepared by Coverdale and Colpitts, consulting engineers, termed the project practicable, outlined recommended specifications

MAP CONTINUED NEXT PAGE



BRIDGING A CHASM

Two of the three major bridges will cross deep ravines at exceptional heights. These pictures show work being done by contractors Lewis & Bowman of Goldsboro, N.C., on the piers for the structure that will span Bluestone River Gorge, about ten miles from the southern end. The roadway will be 255 feet above the stream. This compares with a height of 133 feet for Brooklyn Bridge and 252 for George Washington, both in New York City. Deep box trusses of steel will be supported on four piers, the tallest of which will rise 128 feet above its foundation. Each pier has two legs, each 20 feet square, that go down into the ground as much as 32 feet. They are being poured with concrete mixed near the south end and pumped elsewhere through 8-inch pipe. The bridge will be 36 feet wide and carry two 15-foot traffic lanes with a 3-foot walkway on each side. A service center and snack bar will be provided at one end of the structure, which is expected to be one of the chief points of interest to tourists using the turnpike.



Section 3

and estimated the cost of construction.

The preliminary investigations included counting traffic at different points to learn which of the existing highways were being used most and also canvassing leading trucking and industrial concerns to determine the origins and destinations of their major shipments. These studies showed that there were substantial freight movements both to and from the Charleston, Huntington and Wheeling districts in West Virginia—southward to the industrial areas of the Carolinas and northward to the Pittsburgh, Akron, Cleveland, Toledo, Detroit and Chicago sections.

CONSOLIDATING FILL

A capsule description of the sequence of main operations involved in turnpike building would read: excavate, haul, spread and compact. These views show the two last mentioned items. At the top a carrying scraper is pictured spreading the load of dirt that it had scooped up from a higher spot a few minutes before. The pygmy appearance of the driver indicates the size of the equipment. Compacting fill in the background is a sheep's-foot roller of conventional type. The other picture shows a new kind of roller that rides on four closely spaced pneumatic tires arranged in line under the center of a compartmented metal box that can be weighted with earth as desired. The wheels are mounted two each on oscillating trunnions that provide for individual wheel loading. This keeps all wheels in contact with the ground regardless of surface irregularities that may tilt some other types of rollers. The 18x24-inch tires are inflated to 80-100 psi pressure. On this job, the over-all roller weight is usually 50 tons.

Various possible turnpike routes were investigated for six months. This involved examining all existing highway and topographical maps and aerial photographs and was followed by reconnaissance on the ground and from the air. Once the general route had been selected, more detailed studies were made, including field investigations on which to base estimates of the volume of work and materials that would be required. In this connection, the Mott Core Drilling Company, Cunningham Core Drilling and Grouting Company, Pennsylvania Drilling Company, and Giles Drilling Company sampled the subsurface at many points along the proposed route. Borings made with core drills and augers were supplemented with resistivity tests. Casings were driven and the soil column washed from within was examined. Thereafter, dry samples were taken by driving below the casing.

With these matters out of the way, the financing arrangements were completed when a group of 188 investment concerns headed by Bear, Stearns & Company underwrote a $96-million bond issue. Bids for first contracts were asked a few weeks later and construction was started in September, 1952. Most of these contracts are now either finished or nearing completion and paving contracts have recently been let. Unless there are unforeseen delays, the turnpike will be open by next August.

The rugged terrain presented a challenge to the designers. The route crosses a part of the Allegheny Plateau, which consists of nearly horizontal beds of sandstone, shale and some limestone interspersed with numerous seams of coal that range in thickness from a few inches to several feet. The whole complex has been intricately carved by streams into a maze of narrow canyons and steep-sided

RUNNING ON THE BIAS

Modern roadbuilding equipment can negotiate some topography that was: ormerly thought to be reserved for burros and mountain goats. Here is a well-loaded Euclid truck ambling down a steep slope, which it must, of course, climb on the return trip.

DERELICT

This house was sitting squarely in the middle of the turnpike right of way and its owner chose not to abandon it until he was in danger of being carted away with it. In all, approximately 700 homes were razed or moved. The construction budget carried an item of $3 million for acquisition and disposal of real estate.

hills. Because of these adverse conditions, the original intention of building a divided highway with two lanes in each direction was abandoned as being too costly to pay out with the patronage projected in the early years of the turnpike's service.

Near the northern end, in particular, Nature has been niggardly in leaving the room necessary for a dual highway. In some stretches a stream, a state highway and railroad tracks already fill most of the available space. Existing roads must, of course, be left there, albeit some 30 miles of them are being shifted to let the new expressway go where its designers have located it. Likewise, there has been considerable diversion of streams. Even so, in the northern portion, a divided roadway would have fitted so tightly that costs would have soared. It was accordingly decided to construct a single 2-lane highway with modifications where they are needed to prevent traffic slowdowns. The same problem will remain, of course, if dualization is carried out in the future. The solution will be left to those who may have to deal with the matter then. For example, the tunnel has been driven only two lanes wide. At the same time, provisions for future development are being made wherever they are economically feasible.

The turnpike will normally consist of two 12-foot lanes, flanked on either side by a 9-foot paved shoulder where disabled vehicles may park. Bridge crossings will be 30 feet wide—sufficient for two lanes of traffic even when a vehicle is forced to stop at one side. Grades will exceed 3 percent in but a few stretches, and the maximum will be 5 percent. On the uphill side of the longer and steeper slopes there will be a third "creeper" lane that slow-moving trucks may use without blocking the progress of faster-traveling vehicles. The sharpest curves will have radii of 1000 feet and drivers will be able to see so far ahead that running at 60 miles per hour will be safe. It is, in fact, not intended that the route shall become a speedway, and safety has been a paramount consideration of the designers.

There will be no grade crossings, traffic lights or left turns. At the intermediate interchanges, cars will be able to enter or leave the traffic streams without causing vehicles already on the pike to slow down. Guard rails will be erected wherever embankments exceed ten feet in height. The ruling right of way will be 250 feet. Only authorized service stations, restaurants and other facilities for travelers will be permitted, and the usual ban on billboards and other unsightly objects will be in force. From a scenic standpoint, the highway will rank high. Toll for the full length has been tentatively set at $1.55 for passenger cars and up to $6.15 for the heaviest trucks and buses.

The northern terminus will be just south of Charleston on the east side of the Kanawha River at about 600 feet altitude and connected with the city by an existing modern wide concrete highway. Almost immediately, the turnpike will cross the river, and to gain altitude for that purpose it will wind around a hill

DIVERTED STREAM

Where creeks trespassed on the turnpike route, they have been shifted. Shown here is the new channel carved out of rock for a stream at Cirtsville, on the contract of Clark-Farrell-N.H. Rodgers & Sons.

THE ROCK LOADERS

After the drillers and blasters come the power shovels and trucks. Most seen are 2½-yard shovels, such as the one pictured at the right. It was working on one of Nello L. Teer's two contracts. Among the larger shovels are the one shown in the center, photographed on the S.J. Groves job. Biggest of all is one employed by Latrobe Construction Company (bottom). Its 4½-yard bucket fills a truck in three passes.

several hundred feet high, decribing more than half of a circle and ending up facing directly across the waterway for a straightaway entrance to the bridge. This maneuver will give travelers from the north a rather spectacular introduction to the pike and also, if the expected northern extension materializes, will provide a suitable junction point without the necessity of leading traffic on to the riverside state-highway connection with Charleston.

The route will follow the Kanawha upstream for approximately nine miles, then go up Cabin Creek Hollow for ten miles and tunnel through a ridge to Paint Creek Hollow. Emerging from the bore, which will be the only one on the pike, it will cross a high bridge and then descend to the valley. Proceeding up Paint Creek, it will pass close to the city of Beckley and thence traverse more open country across Flat Top Mountain, where it will reach its highest elevation of 3250 feet. Ten miles north of Princeton, it will cross the Bluestone River on a high bridge. Despite the difficulties imposed by Nature, the route will nowhere deviate more than six miles laterally from a straight line drawn between its terminals.

The difference between building a turnpike and an ordinary modern highway in the same general region is mainly one of magnitude. In either case, the operations consist essentially of excavating earth and rock, hauling it to fill areas, spreading it, compacting it and, finally, paving the newly formed surface. On a turnpike, though, these things are done on a larger scale. Grades are lower, roadways are wider and straighter, and that means deeper cuts, higher fills and more shifting of material. To keep costs as low as possible, all types of roadbuilding are nowadays highly mechanized and this applies especially to big jobs such as this one, where "tight" schedules must be followed to finish contracts in the allotted time. An unofficial survey made in July revealed that there were 871 pieces of machinery in service on the turnpike, and some of it was larger than any previously used on a West Virginia construction job. Conversely, there were only 2200 workers. The speed with which some of the grading contractors have handled their portions of the work is indicated by the fact that one of them completed more than $1 million worth in the month of August alone and another one almost reached the million-dollar mark in July.

To expedite construction, the work of clearing, grading, tunneling and erection of bridge substructures was divided into 22 contracts that aggregate approximately $45 million in bid prices. The largest of them in all respects is one for $6,184,347 held by Ralph Mills of Frankfort, Ky., and Morrison-Knudsen, Inc., Boise, Idaho. It covers nine miles of the route and calls for handling 3,250,000 cubic yards of excavation. Next largest is the $5,864,541 contract of S.J. Groves & Sons, of Minneapolis, Minn., for excavating and shifting 2,832,000 cubic yards of material on 6.3 miles of roadway. Rock excavation runs heavy on both of these jobs.

In the calls for bids, material to be excavated was not classified, but it has been unofficially estimated at around 40 percent rock and the remainder earth. On some sections in the northern half rock runs as high as 70 percent, but is probably well under ten percent on some of the southern sections. These differences are reflected in the contractors' bids, which ranged from 60 cents to $1.53 per cubic yard for excavation and grading. The character of the material also naturally affects the type of equipment used. In the predominantly rocky northern end there is a higher concentration of drilling equipment and the broken material is generally loaded with power shovels into end-dump trucks. An index to the over-all amount of rock work is found in an informal estimate by powder salesmen that approximately 9,400,000 pounds of dynamite will be consumed. Consumption will run to at least a million pounds on each of five of the contracts and will likely reach 1½ million on one of them.

In the northern half, much of the roadway will be shelved from steep hillsides where slides are liable to occur when the surface material is disturbed. To obtain stabilization, it is sometimes necessary to go close to 300 feet above the future grade line and start excavating. Slides not counted upon have occasionally been experienced, obliging contractors to handle more material than was expected. Where excavation results in steep-sided cuts, the general plan is to break the slopes into a series of benches or steps. Then, if material near the top is dislodged and comes down later, it will be caught on the lower setbacks. In time, experience has shown, the upper slopes will become stable. When this condition has been reached, it will be possible, in the event the turnpike is widened, to take out the lower bench without disturbing the equilibrium of the hillside. Where the line passes through old slide material, the latter, if it is unstable, must be removed and replaced with ma-

terial approved by the engineering staff.

The greater part of the drilling is being done with wagon drills. Holes are usually spaced about 6 feet apart in both directions and drilled 18 feet deep, which is the equivalent of three steel changes. The use of detachable bits is almost universal and they are, with few exceptions, of solid steel rather than steel with tunsgten-carbide inserts. This is partly because most of the rock is soft enough to be drilled readily by plain steel bits and partly because the contractors feel that there is too much chance of the costlier bits being lost or misplaced and covered up on a job of this kind where most of the drill runners were at the outset inexperienced in such work. Most of the contractors start the holes with bits of 2¼-inch diameter, but one of them uses the 3-inch size. This results in slower drilling, but he believes the holes stay open better and are consequently easier to load with explosives. Not a single grading contractor maintains facilities for resharpening dulled bits or reshanking and rethreading drill rods. Instead, these services are performed, on a fee basis, by custom shops in Roanoke, Va., Frankfort, Ky., and Pittsburgh, Pa., that pick up and return the material on regular schedules.

Air for operating the wagon drills is furnished entirely by portable compressors. Easily predominating here is the diesel engine-driven Gyro-Flo machine introduced in recent years by Ingersoll-Rand Company. A check on October 1 showed 59 of them in service, including 52 of 600-cfm capacity, three of 315-cfm size and four of 105-cfm rating. Their combined capacity is 32,565 cfm, which is about one-third more than could be produced by the stationary air plant used in excavating for Hoover Dam.

Where rock is heavy enough to require shooting, broken material is generally loaded by 2½-yard power shovels into trucks of 15- and 22-cubic-yard capacity. Northwest 80D shovels outnumber all the others, with 42 of them in action. The majority of the trucks are Euclids, the company reporting 189 of them in service at the end of September.

On the southern half, where rock is not prevalent, the attack naturally calls for different equipment. Self-loading carrying scrapers are largely used there, with a "rooter" frequently run ahead of them to loosen the more tightly consolidated material so that the huge carriers may scoop up their loads easily. The scrapers spread their burdens evenly as they dump them.

Because paving will follow closely after grading and there will not be time for fills to settle naturally, the specifications require that they shall be compacted as they are built up—the earth, after each layer of not more than 8 inches has been spread, and the rock after each additional 24 inches. For this purpose, the familiar old-style rollers with three wide steel wheels or rolls are most used where rock runs heavy. Where earth predominates, either or both of two types of machines are employed. One is the conventional sheep's-foot unit and the other the multiple pneumatic-tire model that has come into use during the past six years. The first ones were used by the Army Engineers on material containing cobbles that could not be satisfactorily packed with sheep's-foot rollers. After serving well on several earthfill dams in the West, they were formally approved by the Army for use on a wide range of granular and cohesive soils. Tests made at that time indicated that they can be pulled so fast (up to ten miles per hour) that they do their job at a much lower cost than the sheep's-foot type and also that they can be used sooner after a rainstorm than any other kind because ground that has been compacted with them absorbs less water.

Although the major use of air is for operating rock drills, it has other applications of importance. As it is impossible to consolidate earth close to concrete box culverts, bridge piers and other structures with the heavy rollers, this is done with hand-held backfill tampers. Large-diameter corrugated steel culverts are shipped in sections that have to be bolted together to make up the complete circle. Nut-running on the bolts is speeded up with pneumatic impact wrenches. Some of the contractors have field shops for maintaining equipment, and these make use of air tools. Probably the largest shop—that of S.J. Groves at East Kingston—has an Ingersoll-Rand compressor for inflating tires and operating tools. The latter include two sizes of I-R impact wrenches. Welding sets are on hand for doing various types of work, including the renewal of worn or broken teeth on power-shovel buckets. On the Groves, Lundin & Cox job two engines for Euclid trucks are in the shop for overhaul at all times, and impact wrenches help the crew recondition them for use in the 24 Euclids the firm operates.

DRIVING TUNNEL

A lot of mileage will be saved by running the turnpike through a tunnel connecting Cabin Creek and Paint Creek hollows. The 2784-foot bore was excavated approximately 33 feet wide and 30 feet high. It was driven full face by 13 Ingersoll-Rand drifter drills mounted on a 37-ton carriage that traveled on crawlers. It is shown (left) at the drilling face. All driving was done from the south portal, shown at the right. Entering the bore at the left side is the pipe through which 21,000 cfm of ventilating air was forced up to the working zone by an Ingersoll-Rand 200-hp blower. South-bound motorists will emerge from the tunnel onto a high bridge across Fourmile Fork Creek.

All of the grading contractors service their mobile equipment on the job, and it is brought in only when in need of major repair or replacement. Trucks carry gasoline, oil and water to the machines that use them and supply compressed air for inflating tires and pressurizing grease guns from a small gasoline engine-driven compressor. A small welding outfit permits repairing many breakdowns right where they occur. Most of the jobs run two 10-hour shifts (some three 8-hour shifts) six days a week. Portable generating sets provide light for afterdark work.

Most of the contracts do not extend over much territory, and it is not difficult for those in charge to keep in touch with their crews. However, at least three of the contractors have installed 2-way radios in their field offices, trucks, foremen's cars and some other pieces of mobile equipment. One of them, Nello L. Teer, of Durham, N.C., uses the same wave length as in Mr. Teer's private airplane and in the home office. The latter, however, comes within range only occasionally when meteorological conditions are favorable.

The turnpike's single tunnel is being driven and lined with concrete by Bates & Rogers, of Chicago, Ill., under a $2,858,043 contract that carries a time limit of 470 days. A separate contract for $257,999 covers the construction of piers and abutments for Fourmile Fork Bridge, immediately south of the tunnel. Driving of the bore, which was holed through on October 2, entailed the excavation of almost 100,000 cubic yards of rock, and 25,000 additional yards was removed in facing off the south portal. The north portal was faced by Nello L. Teer as a part of the grading contract on the stretch of pike connecting with the bore at that end. (See front cover.)

The tunnel was excavated approximately 33 feet wide and 30 feet high. When concreted, it will be 28 feet, 9 inches wide. Bates & Rogers drove the full length from the south portal, working uphill on a 3.25-percent grade and thus taking advantage of gravity drainage. Most of the time, however, there was comparatively little water to contend with other than that used by the drills and for wetting down the muck pile in accordance with the specifications. As the sedimentary strata slope gently downward in the opposite direction to the grade of the bore, the tunnelers worked across the beds at a slight angle and consequently encountered varying types of rock. It ranges from soft to fairly hard, from loose to well consolidated, and occurs in thin and thick layers and even includes some thin coal seams. As a result, the opening had to be supported with steel sets throughout its length.

The tunnel was driven full face with the aid of a 3-platform, 37-ton steel gantry or jumbo designed by the contractor and representing experience accumulated in driving three recent railroad tunnels in West Virginia in much the same type of ground as was encountered on the current job. The carriage is mounted on four crawler units—two on each side—and pulled to and from the drilling face by a tractor in around five minutes. This type of traction worked out well and eliminated the need of rails, the laying and maintenance of which are always time-consuming and often troublesome. When the central portions of the two lower platforms were folded upward, the resulting opening was large enough to pass all equipment used at the face, including the Lima 2-yard power shovel with 24-foot boom that loaded muck. Broken rock was hauled by Tournarockers, which disposed of their loads just outside of the tunnel portal. Four of these carriers sufficed to handle the job.

On the carriage were 13 Ingersoll-Rand DB-35 power-feed drifter drills on 48-inch aluminum shells. Four of them were mounted under the lower platform on conventional columns and arms. Four others on the first platform, two on the second platform and three on the top platform were all mounted on I-R air-operated booms that permitted readily shifting them so as to cover a considerable area of the drilling face. Drilling was done with detachable steel bits, starters being of 2⅛-inch gauge.

A drilling round consisted of from 90 to 140 holes, depending on the nature of

the rock. The depth of holes also varied from 8 to 12 feet in accordance with the variation in the spacing of steel sets, which ranged from 2 to 8 feet in the different types of ground penetrated. For example, where the sets were to be placed either 2, 4 or 6 feet apart, a 12-foot round was drilled. This provided sufficient advance for setting steel right up to the face. This could not be done with a 12-foot round, however, if the sets were to be placed 8 feet apart, and the round was accordingly changed to 8 feet. For the most part, the spacing of sets increased as the heading advanced into the mountain.

Because of these changing conditions, the time required to complete a cycle of operations varied somewhat from time to time. When the job was visited, around 1900 feet had been driven, with 800 feet remaining. The breast was then in a thick layer of well-consolidated rock and 8-foot rounds were being drilled. The operating timetable allowed an average of 3½ hours for drilling, loading and shooting; 3 hours for mucking; and 1½ hours for setting steel. On this basis, 17 rounds were being completed weekly for an advance of around 137 feet, work being carried on full time for six days a week.

The 8-inch H-beam supporting steel, consisting of two side posts and an arch section divided in the center, was snaked in by tractor immediately following the completion of mucking and set with the aid of the shovel. The side posts were placed on precast concrete blocks and shimmed under their bases to get the proper elevation to insure a snug fit of the arch section against the rock overhead. Steel lagging was placed between sets to support the roof firmly and prevent loose rocks from falling.

Before tunneling could be started, the contractor had to build an access road up to the portal site from the valley almost 300 feet below. Because there was no room on the mountainside for offices and shops, the operating base was established at the foot of the slope. A concrete mixing plant, with facilities for storing cement and aggregates, was set up a few hundred yards away alongside passing railroad tracks. While the tunnel was being driven, the plant was operated to furnish concrete for the piers of Fourmile Fork Bridge. It is estimated that 21,000 cubic yards of concrete will be required for lining the tunnel.

The tunnel walls will be faced with buff-colored glazed tile with desirable light-reflecting properties. The lighting will be designed to simulate daylight, and it is thus expected that drivers will notice little change when entering or emerging from the bore in daytime. Fresh air will be provided from ventilation plants at each portal.

During the tunnel-driving period, Bates & Rogers worked about 45 men per shift. M.C. Warmbier is project manager, A.G. Cunningham is engineer, and J.C. Fore is superintendent. The tunnel was designed by Singstad and Baillie, of New York.

Although the Kanawha River crossing at the northern end of the pike will be the longest of the three major bridges, the two others will be more spectacular because both will cross valleys at unusual heights. The roadway of the Fourmile Fork span will be 280 feet above the stream, or about 25 feet higher than that of the Bluestone River Bridge. A peculiar fact is that the main central spans of the two bridges will be almost identical, both 503 feet, 10⅞ inches long. The depths of their trusses at equivalent piers will differ by only 16⅛ inches (130 feet, 10⅛ inches for Fourmile Fork versus 129 feet, 6 inches for Bluestone) and this is accounted for by the difference in gradients of the two roadways. The steel superstructure of both bridges will rest on concrete piers rising high from the valleys below. In total length, Bluestone will exceed Fourmile by 104 feet, 6 inches because it will have one more approach span.

It is believed that these two bridges will be the highest on any major highway in the nation and certainly the loftiest on any turnpike. Neither, however, will compare in that respect with the 880-foot suspension bridge that spans the Royal Gorge of the Arkansas River in Colorado at the dizzy height of 1260 feet above the stream.

The Kanawha River Bridge will be 2166 feet, 5⅝ inches long and 82 feet above the river. That height is far greater than will be needed to clear vessels that will pass under it, as the river channel is only 12 feet deep at that point.

Howard, Needles, Tammen & Bergendoff designed all three major bridges and is overseeing their construction. These three structures will contain 20,691,570 pounds of steel, as against 15,670,000 pounds for all the other 78 bridges on the turnpike. It is being fabricated by Bethlehem Steel Company and American Bridge Division of United States Steel Corporation, and the latter concern will erect all of it.

Howard, Needles, Tammen and Bergendoff serve as general consultants for the entire construction program, but to simplify supervision it is divided into three sections and each has its own engineering supervisor. Section 1, which runs northward 20 miles from the southern extremity, is in charge of Capital Engineering Corporation, of Dillsburgh, Pa. Section 2, comprising 30 miles in the center, is under Fay, Spofford & Thorndike, of Boston, Mass. Section 3, made up of 38 miles at the northern end, is supervised by Gannett, Fleming, Corddry & Carpenter, of Harrisburg, Pa.

The paving contracts were let in sections with Section 2 being opened for bid first. Contractors were given the option of bidding on either concrete or asphaltic-concrete pavement, with the commission reserving the right to award either type. No awards were made until bids for all three sections had been received, after which awards to the low bidders for concrete pavements were made on October 9. The successful bidders for the various contracts are: Section 1, J.B. Michael and Company, Inc., Memphis, Tenn.; Section 2, Nello L. Teer Company, Durham, N.C.; Section 3, south part, Bero Engineering and Construction Corporation, Hampton, Va.; north part, R.B. Tyler Company and Breslin Construction Company, Louisville, Ky. There will be a crushed-stone base of select material 14 inches in thickness on which an unreinforced concrete slab of 9-inch thickness will be laid on a 1-inch sand cushion, giving an overall thickness of 24 inches.

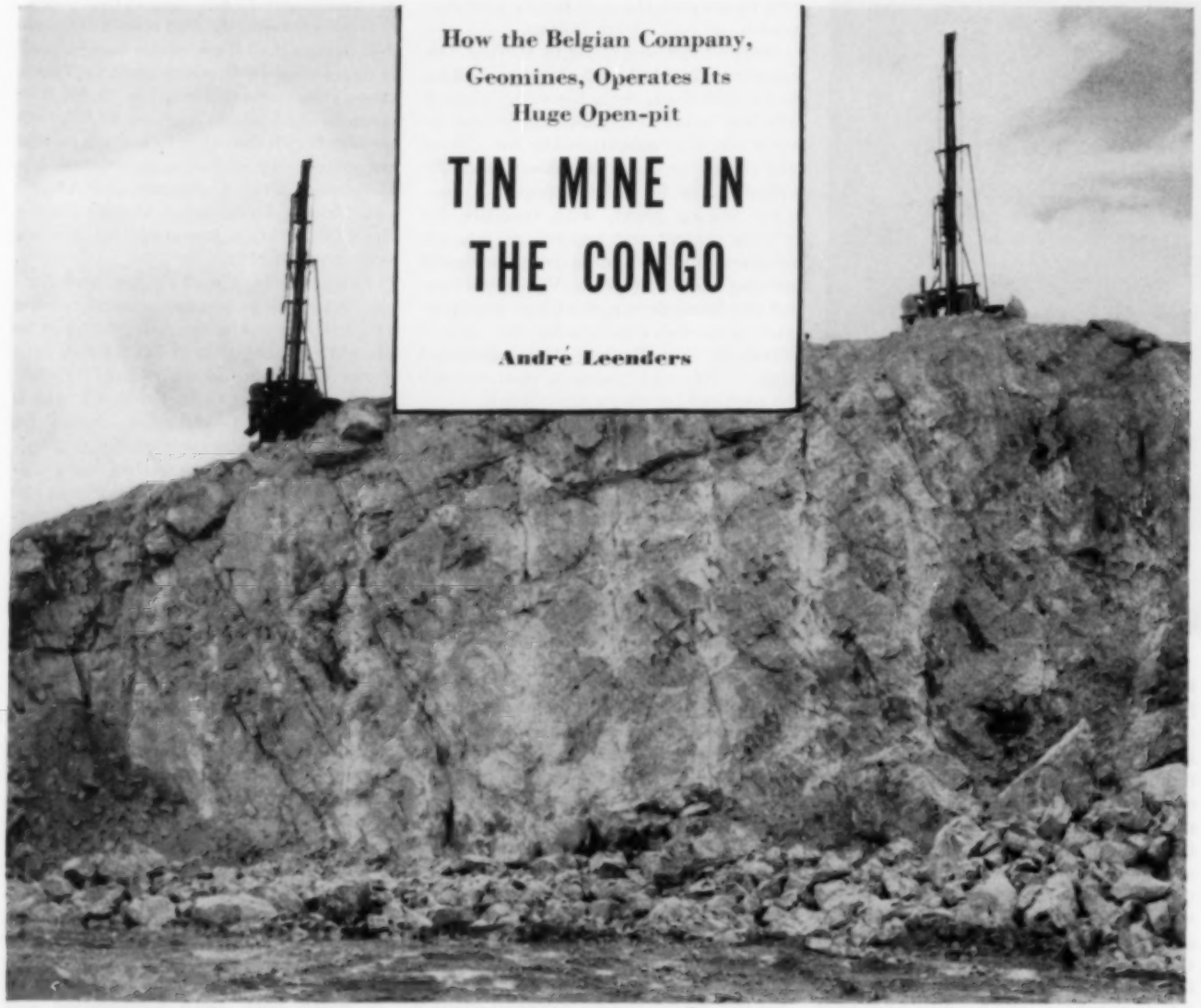
It is estimated that 586,395 barrels of cement will be needed to lay the 1,562,670 square yards of pavement. The initial cost of concrete will be around $4 million greater than for blacktop surfacing, but it is thought that the annual maintenance charge will be less. It is also contended that concrete has better light-reflecting and nonskid qualities. The choice of concrete represents a reversal of the recent turnpike trend towards blacktop.

The West Virginia Turnpike Commission is composed of D.Holmes Morton, chairman; William G. Stathers, vice-chairman; Edward J. Flaccus, Hugh F. Hutchinson and H.K. Griffith. Ray Cavendish is executive director and Allen C. Kinnaman secretary-treasurer.

How the Belgian Company, Geomines, Operates Its Huge Open-pit

TIN MINE IN THE CONGO

André Leenders



FRACTURED GROUND

In some places, the pegmatite is fissured as shown here. Such cavernous openings add to the difficulties of drilling. The undercarriage of a Quarrymaster is shown in the background.

LOFTY PERCH

Two Quarrymaster drills on top of a 60-foot bench. The marks of previously drilled holes are visible on the rock face. This is the hard pegmatite that occurs below the altered surficial rock that ranges up to 160 feet deep and can be loaded by power shovels without being drilled and blasted. The ore exists in two pegmatite lenses, each about 3½ miles long and 2 miles apart, in the schistose country rock. The principal mineral, cassiterite (tin oxide), is disseminated fairly evenly through the pegmatite as black, flattened grains less than two-fifths of an inch long and averages 4-6 pounds per cubic yard of rock. A combination of tantalum and columbium is of secondary importance and is usually about 5 to 7 percent as abundant as the cassiterite. The existence of the deposit has been known since 1912 and it was first worked by sluicing. Extraction of the upper, soft kaolinized material began in 1933, and the deeper hard portion has been mined since 1946.

GEOMINES, an abbreviation for Cie Géologique et Miniére des Ingénieurs et Industriels Belges, was founded in Liége in 1910 by a group of Belgian engineers and businessmen. Following arrangements with the Comité Spécial du Katanga (C.S.K.) and the Government of the Belgian Congo, the concern began prospecting for minerals in the northern territories of Katanga. The C.S.K. (originally Compagnie du Katanga) was promoted by Belgium's King Leopold II to control the Katanga territories and develop their resources. Important coal deposits were soon discovered west of Lake Tanganyika and, later on, alluvial and eluvial deposits of cassiterite (tin ore) in the Mwanza and Manono areas.

In 1920 the company turned into a mining enterprise and decided to work, first, the easiest-to-handle cassiterite deposits on the surface. The material was hand-picked and washed in sluices to separate the mineral. In 1925, Geomines opened up the Greinerville collieries and started mining the large reserves near Albertville on the shores of Lake Tanganyika. However, as the coal was relatively poor and the concern did not

QUARRYMASTER AT WORK

Below—Vertical holes, from 12 to 16 feet apart, are drilled from the top of the bench to a depth about 2 or 3 feet below the floor of the pit. The metal barrels mark the locations of holes already drilled.

SECONDARY DRILLING

When the large-diameter blast holes in the hard pegmatite are shot, the rock breaks in big pieces, as shown here, and are reduced to a maximum of 30 inches by secondary drilling with Jackhamers.

TRANSPORTATION BY BELT

At the left is a primary crusher and one of the 20-ton Easton trucks that deliver crude ore to it. Running up the slope at the right is a belt conveyor that takes the ore out of the pit and to a treatment plant. A partly assembled Quarrymaster drill is standing in front of it. The cassiterite ore is concentrated mainly by jigging and the concentrate is smelted. Until the recent slump in the price of tin curtailed operations, Geomines was producing around 1000 tons of crude ore per hour and was preparing to increase this to 1250 tons.

find a sufficient market for it to justify the expense involved, operations were shut down in 1932.

During the late 1920's the company widened its prospecting zone and located new and important deposits of cassiterite mainly in the Manono area in northern Katanga. The ore is found at or near the surface in two large lens-like intrusions of pegmatite. In some places the upper portion has been altered to a much softer secondary material that is comparatively easy to extract. In view of these recently discovered reserves, the organization decided to mechanize the mines and equip them with up-to-date machinery. Authority was obtained to build a 15,000-hp hydroelectric plant on the Luvua River not far from Manono. Thanks to this new station, the main deposits were shortly being processed. Under the procedure now followed, the soft ore is dug with large electric shovels and loaded directly on to belt conveyors that transport it to a washing plant in which the raw cassiterite is extracted. Most of the time the material can be handled readily as it is by the shovels. Sometimes, however, the ground must first be broken up with explosives.

The raw cassiterite coming from the

different washeries is first treated in a concentrator and then in a magnetic separator that segregates minerals of the tantalum-columbium series. Geomines is an important producer of these and exports all of them to the United States. Next, the cassiterite is smelted on the premises and shipped in the form of tin ingots.

During World War II, the company made preparations to supply the United States with large quantities of tin. In 1946, new and important ore reserves were discovered in the unaltered pegmatite that underlies the altered rock that was then being worked. In order to start mining the hard pegmatite without delay, the concern obtained a $1,700,000 E.C.A. loan from the United States with which to purchase the necessary equipment.

In 1951, production of hard ore was started. Under current practices, the top altered rock is removed and sent to one of the washing plants. The underlying pegmatite is then quarried in one bench 50 to 70 feet high. Secondary blasting reduces the blocks to pieces small enough to be handled with electric shovels. Twenty-ton trucks with side-dump bodies unload the rock into a primary cone crusher in the bottom of the open pit. The product of this crusher is then transported by belt conveyor to a treatment plant set on the rim of the mine opening. There the material is reduced to small size by means of successive crushing operations before it goes to a special washery.

RIVER BOAT

The Quarrymaster drills and other large equipment had to be transhipped from Leopoldville, on the western coast of Africa, to the interior. This involved time-consuming transport by narrow-gauge railroad to Bukama, a 7-day boat trip up the Congo (Lualaba) River, and finally a truck haul of 45 miles to the mine.

BIT RESHARPENING

A 6-inch Quarrymaster Carset (tungsten-carbide-insert) bit in position on a stand for reconditioning its cutting edges with the Ingersoll-Rand 4GV8 grinder shown beside it. The tool is hand held during the operation.

LARGE SHOVEL

Power shovels are run with electricity that is generated at a company-owned hydro plant on the Luvua River. The shovel shown has a 6-yard bucket. A Quarrymaster is visible in the background.

For putting primary blast holes in the very hard pegmatite, Geomines bought six Ingersoll-Rand Quarrymaster drills. Churn drills also are used but in the softer formations. At present, the open pit looks like a huge arena with one bordering bench that averages 60 feet high. The vertical primary blast holes are carried down to a level 2 or 3 feet below the quarry floor. Experiments to determine the best method of drilling and blasting are still continuing.

In the extremely hard formation in which they are operating, the Quarrymasters have proved to be the most efficient equipment obtainable, drilling 6-inch holes to a maximum depth of 70 feet with an average penetration of 6 to 7 feet per hour. These speeds are remarkable when it is considered that the rocks are among the hardest being handled anywhere on so big a scale. The drilling cost per cubic yard is comparatively low, and this is attributable largely to the low cost of resharpening the 4-point Carset (tungsten-carbide-insert) bits that are being used. The compressors mounted on the huge machines are electric-driven.

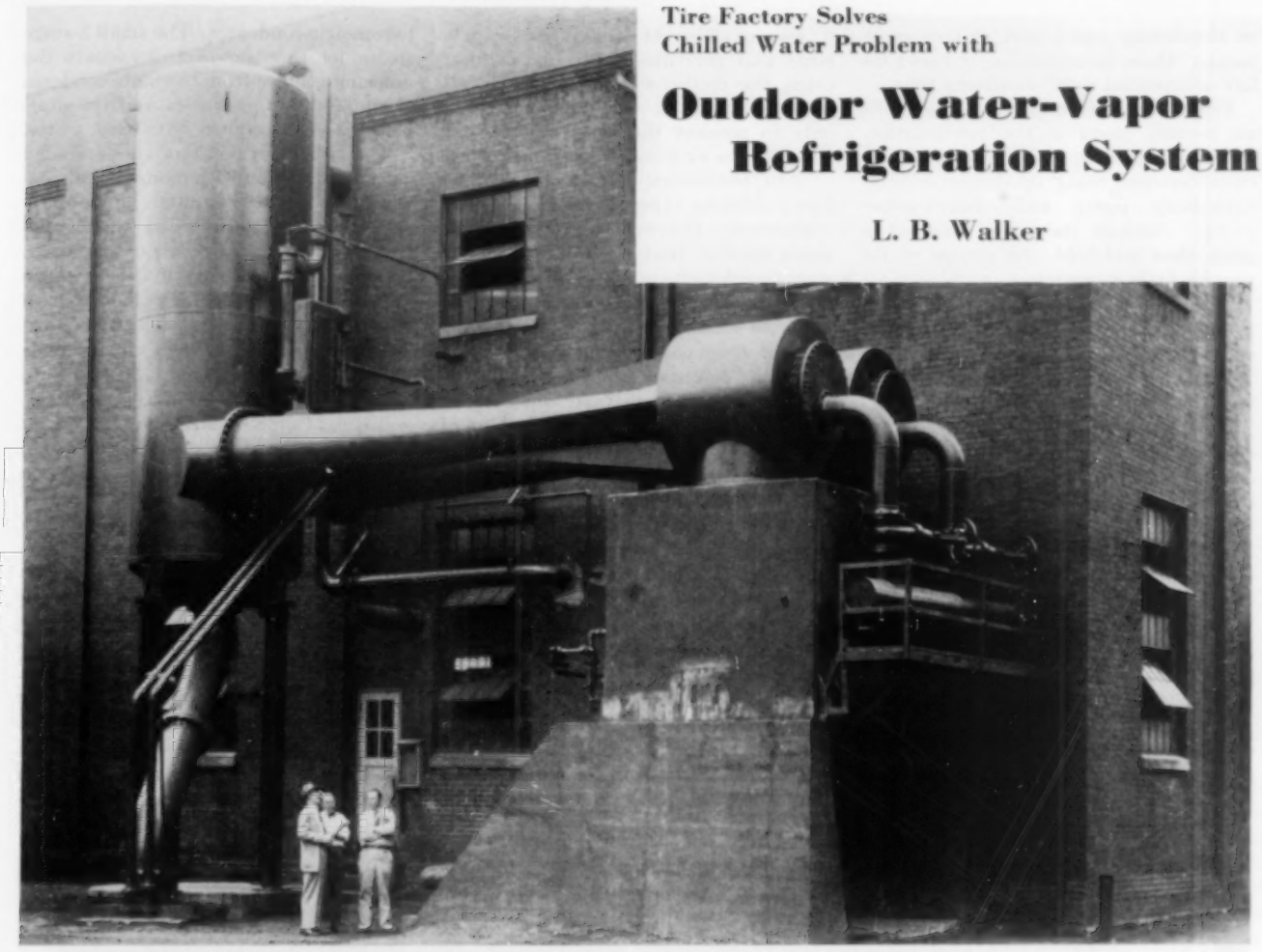
The Quarrymasters are easily moved and positioned for drilling, and when in service each is manned by only one or two natives under the supervision of a European who is also in charge of primary blasting. The first machine was put in operation in July 1951. At the present time, Geomines has 140 white employees and 6000 natives. The yearly production of cassiterite is approximately 4000 tons.

In view of the fact that there has been a change in conditions, it is now the company's intention to reopen the Greinerville coal mines to furnish fuel for the Chemins de Fer des Grands Lacs (Great Lakes Railway Company), for a new cement plant (Cimental) not far from Albertville which is about to go into production, and eventually, for a Belgian association of chemical industries that is studying the possibility of building a large plant for the manufacture of synthetic chemicals and would use the coal as raw material.

Tire Factory Solves
Chilled Water Problem with

Outdoor Water-Vapor Refrigeration System

L. B. Walker



OUT IN THE OPEN

As this picture shows, a water-vapor refrigeration unit requires no housing and this is one of several features that make it attractive economically for services within the range of its cooling capacity. The twin, 31-foot-long horizontal members house steam jets that pull a vacuum on the evaporator underneath them, thus causing some of the water sprayed into the chamber to flash into steam. The heat it absorbs in doing this is extracted from the remainder of the water, which is thus cooled. The entrained vapor and the air are carried into the 25-foot-high cylindrical barometric condenser at the left, where they rise through cascades of falling water. The condenser rests on and discharges its water into a 34-foot-long tail pipe, 20 feet of which is underground. The apparatus is capable of cooling 2100 gpm of water to 65°F. It is used in the summertime when chilled water is needed to cool various heat-generating rubber-working machines. It is operated with low-pressure exhaust steam.

MANY industrial-plant or consulting engineers are called upon occasionally to provide means for supplying chilled water (35° to 65°F) for some process or comfort cooling function. At such times the first thought is, of course, of a conventional refrigeration system, probably one consisting of ammonia compressors with their accessory evaporators, condensers, pumps, high-pressure piping and valves, delicate gauges, insulated lines, etc.

But inquiry reveals that such a plant calls for a high initial investment. Next, it is discovered that the monthly power bill will be of appreciable size. Also, that round-the-clock maintenance will pile up operating costs in these days of high payrolls. Other items that inevitably enter into the calculations are maintenance of the reciprocating compressors—running gear, piston rings, valves, etc.; periodical cleaning of condenser-tube nests and shells and the eventual rerolling or replacing of tubes; upkeep of pipe lines, including valves; and supplies such as refrigerant, lubricating oil and electrical accessories.

Kelly-Springfield Tire Company of Cumberland, Md., which makes various sizes and types of automobile, truck and industrial tires, was confronted with a problem of this kind. Its engineers were familiar with the cost of operating an ammonia refrigeration plant, as the factory had been using three 300-hp single-stage ammonia compressors, arranged in parallel, for twenty years. In fact, rehabilitation of this installation to meet the 1950 needs was considered, but a survey disclosed that its condition was such that the expenditure involved in restoring it to first-class operating status would be excessive. Because of these circumstances, it was decided to look into other types of refrigeration equipment, and every kind available was investigated.

After thorough study, Kelly-Springfield engineers concluded that the water-vapor refrigeration system as manufactured by Ingersoll-Rand Company would best solve their problem. Factors that dictated this belief were:

1– Low first cost. This was less than the estimated cost of rehabilitating the existing ammonia plant.

2– Low power cost. Because exhaust steam at 3 to 5 psi pressure was available and could be drawn upon to operate the new system, power cost would be negligible. The steam was being used for heating during the winter months when refrigeration was not required. Most of it was being wasted in the summer.

3– Low attendance cost. The water-vapor system would need no attention other then starting the flow of steam to the boosters and starting the condens-

er circulating pump and chilled-water pump. Once in operation, it could be left unattended until shutdown time.

4– Low maintenance cost. There are no moving parts in the refrigeration equipment proper; the only ones in the entire system being in the centrifugal circulating pump and chilled-water pump. Because the water handled is pure, clear and cold, the pumps would require little attention.

5– Low-cost piping. Because no high-pressure steam or water has to be handled, the cost of piping would be low. No tricky valves would have to be provided to handle obnoxious gases.

6– Low-cost housing. Not even government low-cost housing projects can approach the economy of a water-vapor refrigeration plant in this respect. No housing is needed; all that is required is a small plot of ground on which the complete refrigeration unit can be made self-supporting.

Because of the large area covered by the tire factory, thought was at first given to the idea of locating several relatively small refrigeration units at points convenient to the different groups of equipment they would serve. That plan, however, would have involved piping low-pressure steam to each unit, so it was quickly set aside for a single large unit near the boiler house. Because the chilled-water piping was already in place, it would be necessary only to connect the new chilled-water pump to the existing circulating system.

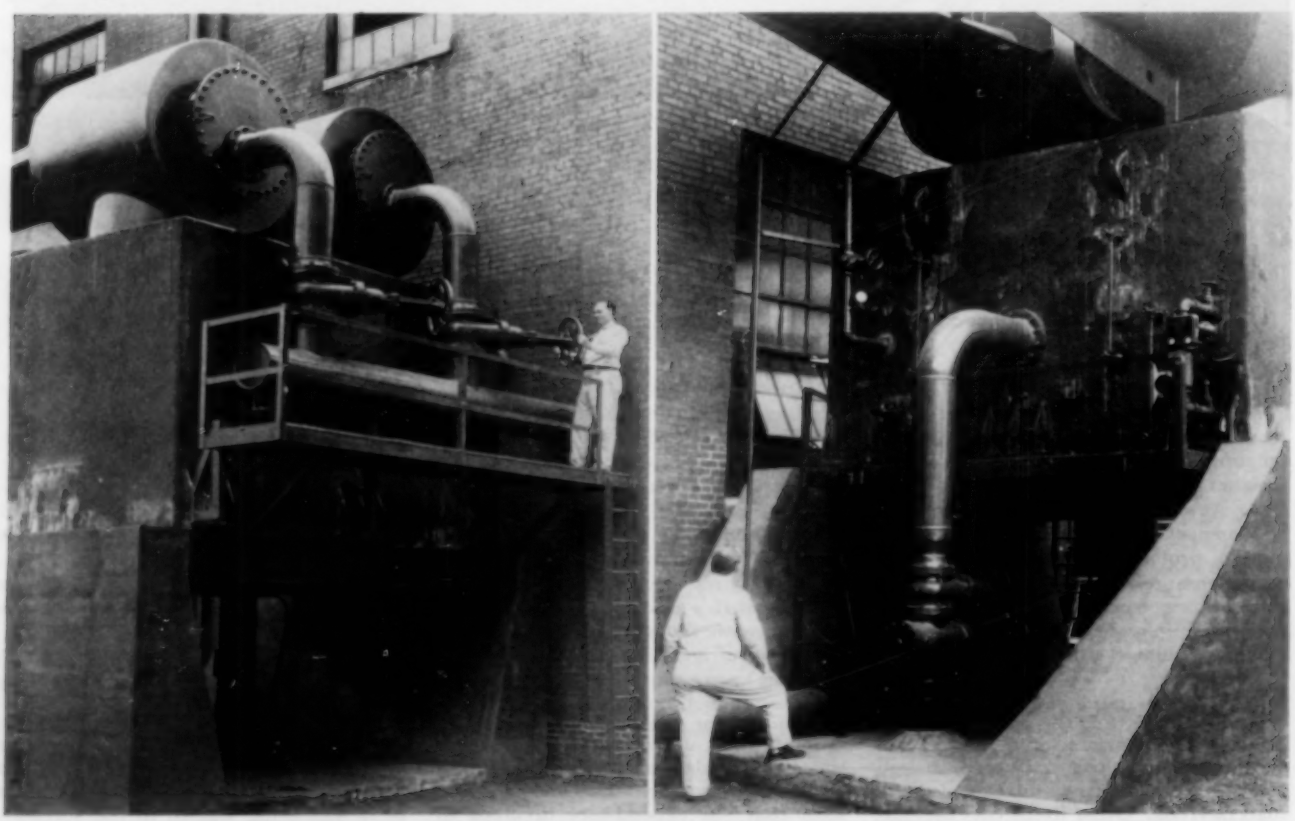
Both barometric-condenser and surface-condenser types of apparatus were considered. However, the Kelly engineers decided that reclamation of the steam condensate possible with a surface condenser did not justify the extra cost it would entail.

After fully considering the foregoing facts, the company, in August of 1950, ordered an Ingersoll-Rand water-vapor refrigeration unit having a capacity of 1140 tons of refrigeration. The equipment consists of a 2-booster, twin-compartment barometric-condenser steam-jet cooler, together with a chilled-water pump and condenser circulating water pump. The unit is capable of chilling 2100 gpm to 65°F and delivering it to the points of application. The main booster jets are designed to operate on dry or saturated steam at a minimum pressure of 3 psi. In this instance, the low-pressure steam is obtained from the exhausts of a large Ingersoll-Rand reciprocating compressor and several turbine-driven pumps. River water is used in the main barometric condenser. The small 2-stage steam jet that serves to evacuate the noncondensibles from the main condenser employs 160-psi steam and its intercondenser is supplied with city water.

The two main boosters are of welded steel construction with monel-metal nozzles. They are mounted horizontally and supported entirely by the evaporator and main barometric condenser. Some idea of the size of the unit can be gained from the fact that each of the main booster jets is 31 feet long.

The evaporator or flash tank is made of welded steel plate and is divided into twin compartments by means of Ingersoll-Rand Company's patented weir construction. This arrangement makes it possible to operate the unit at half capacity when only a light load is required.

The main condenser is of the counter-current type and is based on the disk-flow principle by which the water descends against the rising steam in a series of disks. This takes place at the top of the unit in a cylindrical chamber that is 8½ feet in diameter and 25 feet long. It is mounted on a tail pipe 34 feet long. In installing the latter, the Kelly-Springfield engineers utilized an existing manhole that is connected with the main sewer, which is approximately

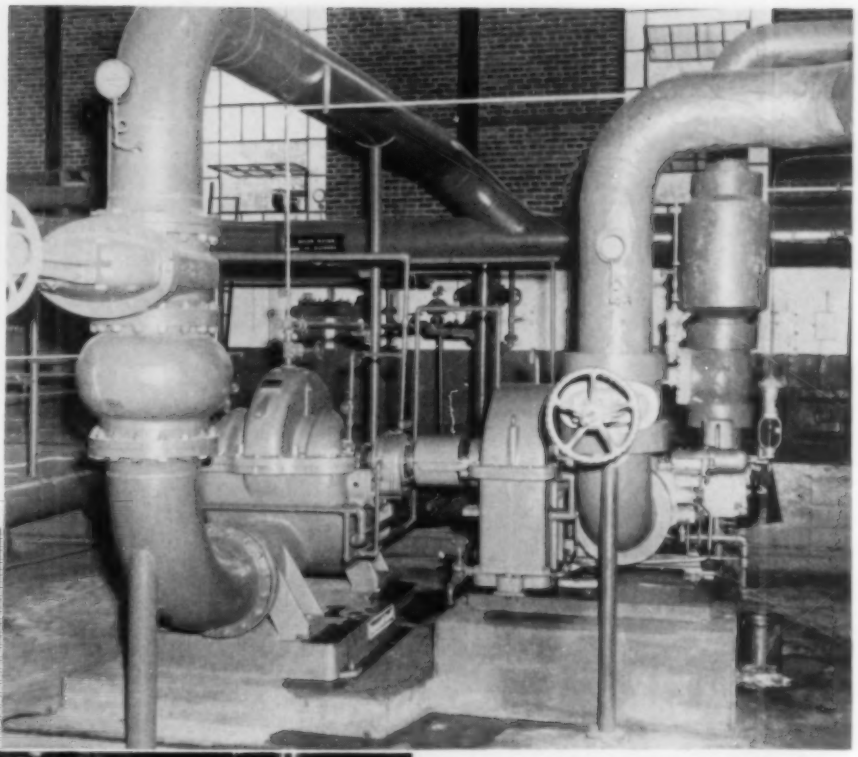


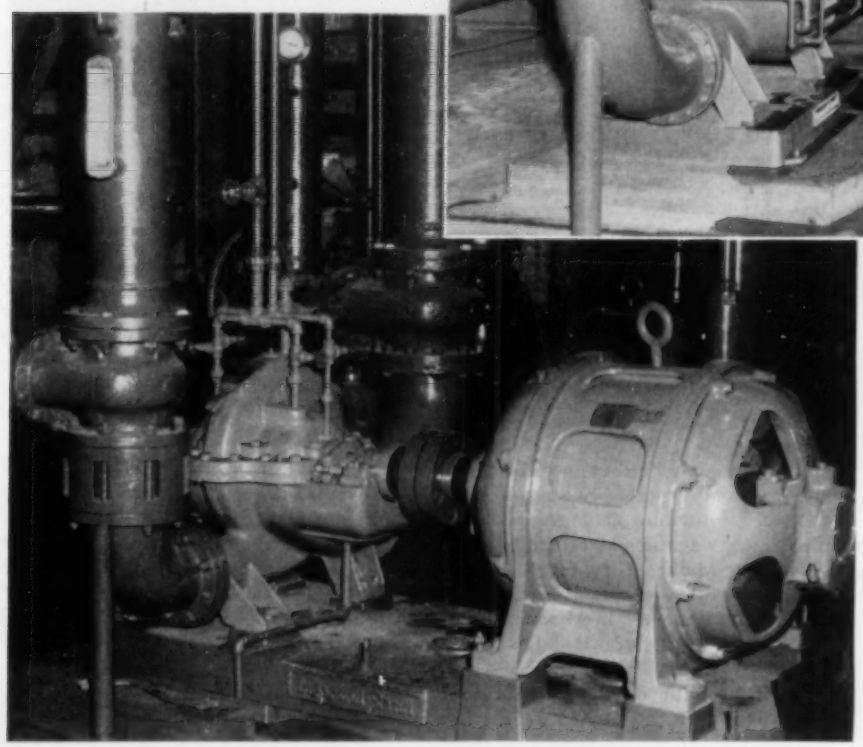
DETAILS OF STEAM-JET UNIT

The wheel the man is holding in the view at the left controls the admission of steam to one of the jets overhead. The other picture shows the welded-steel, internally divided evaporator. The pipe is a return line for water that has performed its cooling service and is being recycled to be chilled again.

SERVICE PUMPS

Water is the jack-of-all trades in this sort of refrigeration system. In the form of steam, it is used in jets to produce the all-important vacuum for the refrigeration cycle. To condense the steam and maintain the vacuum, water in considerable quantities is supplied to the condenser. The product of the unit is more water—chilled so that it can remove heat from various rubber-processing machines. Pumps are important accessories for moving the water. Pictured below is one of two Ingersoll-Rand centrifugal units that transfer the chilled water to the points of use. At the right is another I-R pump that handles the condensing water, which is obtained from a river and has an average temperature of 78°F. The pump has a capacity of approximately 10,000 gpm and is driven by an Elliott 412-hp steam turbine.





20 feet below ground level. The tail pipe is supported at the manhole flange. This scheme brings the condenser proper 20 feet nearer ground level than would normally be the case.

It is worthy of note and certainly indicative of the manufacturer's expert workmanship and the Kelly-Springfield organization's excellent engineering, foundation, construction and installation work that, even though the large pieces making up the water-vapor unit were shipped unassembled and were mostly of welded construction, it was not necessary to shim or strain any of them to make them fit one another and the foundation and pipe connections that were prepared before the equipment arrived.

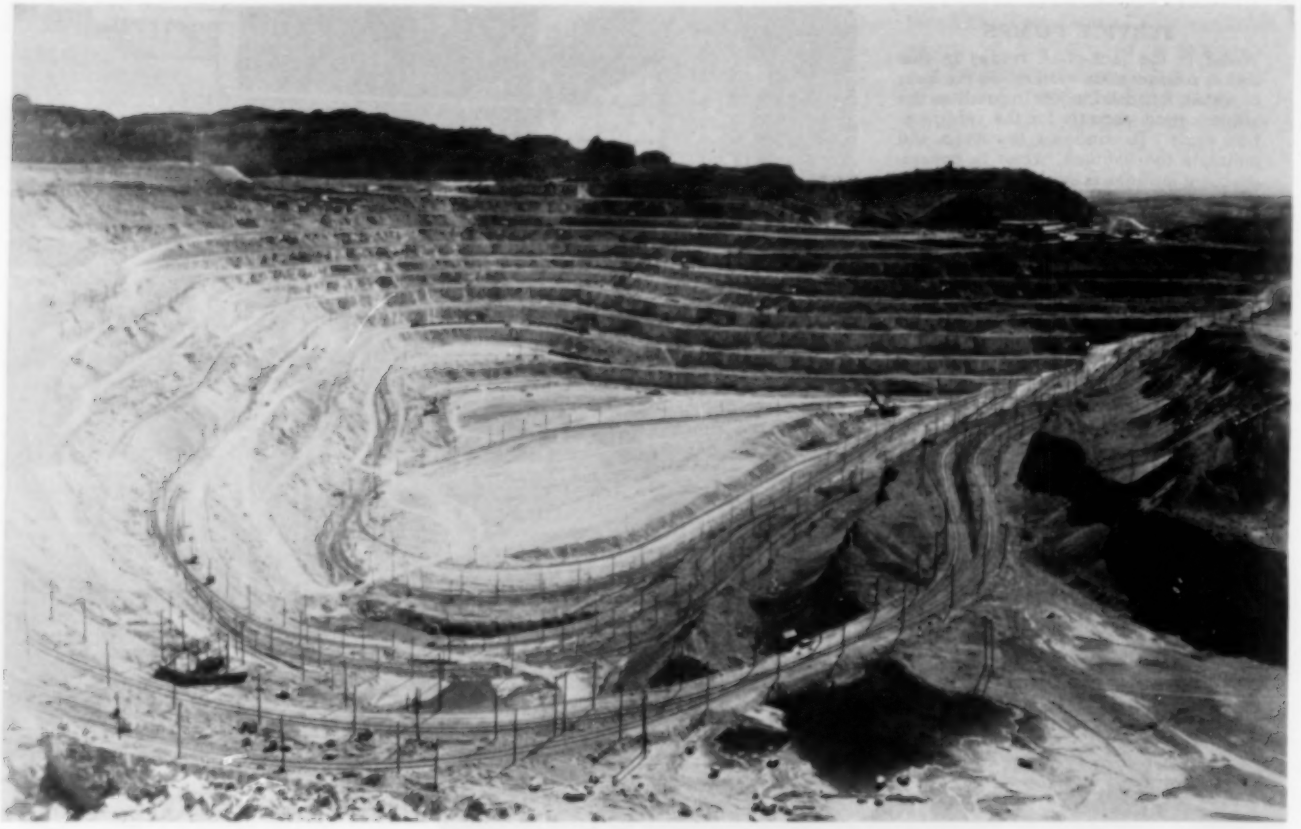
In service, the water-vapor refrigeration equipment operates in series with a cooling-tower system. Cooled water, averaging within 5°F of the prevailing wet-bulb temperature, is delivered by a pump from the tower cold well. The quantity of water supplied is controlled by an automatic flow valve that maintains a constant water level in the evaporator tank of the water-vapor unit. The latter uses only part of the water available from the cooling tower; the remainder is sent to the plant for purposes that do not require chilled water. Actually, then, the factory is served by two separate cooling-water systems.

The chilled water is removed from the evaporator by an electric-driven Ingersoll-Rand single-stage pump and piped to tubers, tuber cooling conveyors, calenders, mills, and cooling drums and rolls. Water delivered directly from the cooling tower is used on banburys, banbury cooling conveyors, mills and for general plant purposes where water temperatures are not critical. Temperatures required at the various rubber-forming machines vary according to the product being processed. Water exhausted from all the equipment on both temperature systems is piped to a common sump and pumped from there back over the cooling tower.

The water-vapor unit has some reserve capacity above the expected demand for chilled water in process work. This has been added to by conservation measures worked out by the company's engineers. This surplus water is being circulated through the cooling coils of a newly installed air-conditioning system in the main office and engineering department. The resulting comfort may be considered somewhat in the nature of an extra dividend from the new refrigeration equipment.

Apart from the use of low-pressure steam and the other economic factors that originally made the steam-jet water-vapor refrigeration unit attractive, the suitability of the type for installation outdoors with no need of an enclosing building, crane facilities, etc., and the complete freedom from maintenance supervision, make this equipment an outstanding example of how large-tonnage refrigeration can be obtained for a very nominal initial investment and be operated at an extremely low cost.

The Kelly-Springfield men responsible for the successful installation and operation of the equipment are Charles L. Herath, chief engineer; William G. Barger, assistant chief engineer; and Claude Nave, project engineer.



SANTA RITA PIT

Where Pattie pecked away, Kennecott has dug a mighty chasm that decreases in width as it grows deeper. Each of the many benches provides room for mining and transportation. The pit has produced 70,000 tons of copper in a year.

Pattie and the Apaches

Canny Pioneer Held Own with Wily Redman but Lost All to City Slicker

Veda N. Conner

THE great Santa Rita open-pit copper mine 16 miles east of Silver City, N. Mex., is famous as one of the world's largest. Few people, however, know that this Kennecott Copper Corporation holding has been in almost continuous operation longer than any other mine in North America. The "almost" came about through the "never conquered" Apaches. They caused every work stoppage of any length in all the 150 years of the Santa Rita's prolific history.

James Pattie, first American owner of the mine, was the only man ever to hold the Apaches in check, to peacefully work the Santa Rita for as much as ten years. Such a truce was never known before—and was never to be known again until the U. S. Army took the field.

Before "Old Pattie" came along in 1826 the Santa Rita had a long succession of operators. Prehistoric Indians had dug out the native red copper for ornaments. Wealthy and influential residents of Chihuahua had sent 20,000 mule-drawn wagonloads of fine copper annually to Mexico City for the royal Spanish mints—the mineral-rich Mogollon mountains were in Mexican territory until the Guadalupe-Hidalgo treaty of 1853. Less influential but ambitious men had brought out a few hundred pounds a year.

All ended in eventual defeat—operators were harassed by hostile Apaches, their Mexican peons killed, their wagon trains smashed and burned. Fields of corn, beans, potatoes—vital to feed workers in that isolated semidesert—were harvested or burned by Apaches.

Convict labor to replace the Mexicans (who were so hated by Apaches that they were shot on sight), soldier convoys, small cannon, all were unavailing. Bribes

TYPICAL MOGOLLON SCENERY

The Santa Rita country of cedars and strange rock formations. The silhouetted detached piece at the left of the high cliff is called the Kneeling Nun.

were impossible, for the wily Apache attacked and fled, then kept a careful distance.

Pattie paid $1000 for a lease on the Santa Rita that would be almost priceless today. Pattie, the trapper, hunter, explorer, protected his investment with as much patience, diplomacy and business technique as would any Kennecott official of today.

Typical of Pattie's method of operation was the way he made his truce. He did not attempt to work the Santa Rita at once. First he bagged two Apache hostages, tied the wild birds and staged an impressive show of his uncanny skill with the rifle. Then he released them with orders to bring in their chief "to make a peace." With only three other white men he met 80 warriors in a grove. But Pattie's ace in the hole was a cache of 30 armed Mexicans in a hidden trench. When diplomacy failed, a signal brought his "army" to their feet. The Apaches recognized a man as well trained in strategy as themselves—or as tricky! With respect and admiration they smoked a peace pipe with Pattie.

Pattie had come to know Indians well in the three years since he arrived from Missouri—so well that he was one of only sixteen survivors of the 116 men who'd accompanied him. As he explored the country to the Pacific on foot he became known as a man who kept his word, who killed game for food and skins and humans in self defense.

When the Santa Rita Apaches argued that Mexicans were fair game because they'd trapped and murdered whole tribes of Apaches by treachery, Pattie swore no innocent Indian would be harmed while he held the Santa Rita. He also swore that if any peon was injured he'd "hunt the perpetrator to the end of the Mogollons."

Soon Mexicans, unmolested, were bringing up copper, gold and silver ore from the single-shaft mine. Their fields were undisturbed, pack mules plodded peacefully southward. At first warily, Apaches brought gifts to old Pattie. When these were received with respect and dignity, cautious visits began, rare but always friendly.

Pattie's dream was to own the Santa Rita outright. He felt, as did many before and after him, that the Santa Rita was inexhaustible. The mine, that more than a hundred years later produced 140 million pounds of high-quality copper in a year, earned $30,000 for old Pattie. In 1836 the Santa Rita was as good as his. When a smooth Spaniard who spoke four languages slept at the mine as did all travelers, Pattie deemed it pure luck. He said he was blood kin of owner Legara. He was a "gentleman," a new species to Pattie, keen judge of mountain and desert men. The Spaniard could carry the purchase price of the mine to Legara and seal the bargain.

LOADING POINT IN PIT

Pattie's pack mules have been transformed into gondolas, his picks into huge electric shovels, and the tempo of the operation quickened a thousandfold.

The crafty and crooked "gentleman" took off toward Mexico with Pattie's gold and was never heard of again. Finally defeated, old Pattie returned to the wilds. As for the Apaches, they returned to unceasing harassment of the Santa Rita.

One hopeful Spanish or American operator after another was driven away by the murderous Indians. But even then the Santa Rita accounted for 80 million pounds of copper during the 19th century.

Today the cedar-dotted hills that hold the tiny dark mine shaft Pattie knew is a vast area of great excavations that encircles part of the town of Santa Rita. Power shovels roar and railroads carry away tons of copper to the huge smelter at Hurley. Pattie's "inexhaustible" Santa Rita provides 97 percent of New Mexico's around $35 million yearly copper output—6 percent of the nation's total—not to mention molybdenum, silver, gold, lead, and zinc.

But calm, able old Pattie would probably take Kennecott Copper's giant operations, its thousands of employees, even its board of directors in his stride. There are no crafty Spanish "gentlemen" among them!

When Time Stood Still

IN 1879, two 6-hp steam-driven compressors in the basement of a house in Paris began delivering compressed air through three miles of piping for the operation of street clocks. Every 60 seconds, an impulse was sent out from a master clock to every connected timepiece.

The scheme worked so well that all of the official clocks were made pneumatic. Parisians were always assured of obtaining the correct time at a glance. Then, suddenly, at midnight on February 18, 1927, every clock stopped and none started again for two weeks. The city's contract with the compressed-air clock company, made in 1887, had expired and time stood still until it was renewed.

Giving Motor Cars the Third Degree

PNEUMATIC FOOT

The driver presses a button to actuate an air cylinder that is hooked up to the foot brake. Instruments record the pressure exerted, speed of the car and time required to stop it. In the other picture, the equipment shown is, from the left: air-cylinder assembly, air tank, highly accurate speedometer operated by a bicycle wheel attached to the rear bumper and shown in raised nonoperating position; and the automatic recording instruments.

ON THE General Motors Proving Ground, an hour's ride out of Detroit, Mich., automobiles undergoing tests are driven an average of 30,000 miles per day and their cumulative travel now aggregates more than 140 million miles. Back of the trials is the desire to find out how the vehicles react under just about every conceivable kind of driving condition. To make the tests as unbiased as possible, they are conducted by a separate staff of engineers—men who have nothing to do with the design or manufacture of cars. The automobiles themselves are not picked ones sent out by the factories, but are purchased from dealers in the open market. They include both General Motors and competitive models.

Foremost among the objectives is that of learning how safe the vehicles are. Two of the tests conducted for this purpose depend on air-operated equipment. One of them is designed to determine how the brakes react and, in order to eliminate human variables, the pressure on the brake pedal is applied by means of an air cylinder. It can thus be definitely measured and recorded and can be held constant for as long as may be wished or varied exactly as desired. The force brought to bear may simulate the push of a woman's foot or that of a burly truck driver's.

The car is stopped at different brake-application pressures from speeds of 25, 50 and 70 miles per hour and the rate of deceleration indicated on an instrument. Inside the latter is a movable weight that tends to swing forward as the speed is slackened. The distance the weight travels is recorded on moving paper tape, and along with it appear the pressure on the pedal, the distance the pedal was depressed and the time required to stop the car. The information enables the engineers to determine whether the brakes are adequate to meet all reasonable service demands.

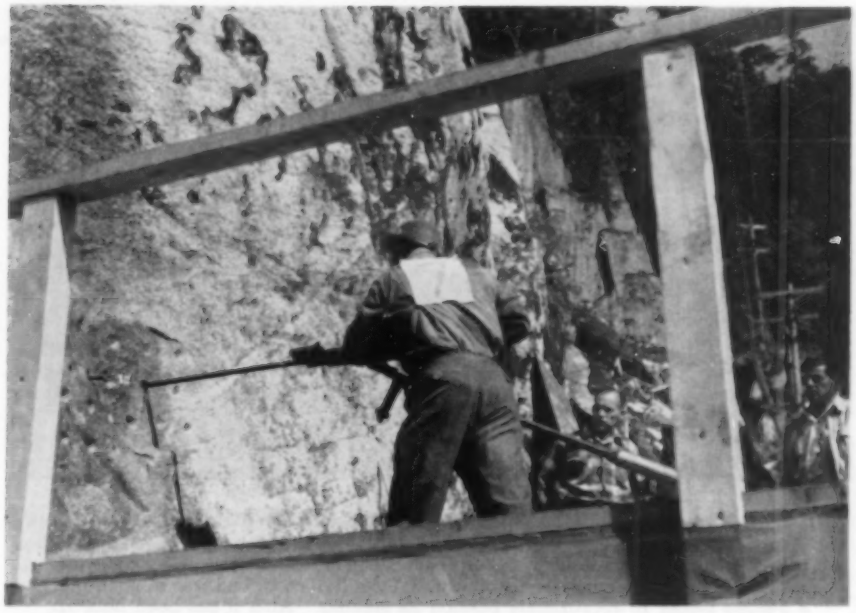
With the same equipment it is determined whether the brakes have a tendency to "fade"; that is, to lose some of their effectiveness when they become heated from hard use. Several quick stops are made from high speeds, and if they require progressively longer periods, brake fade is indicated.

The effectiveness of latches and locks on car doors is determined with the aid of an air-actuated brace extended between opposing doors. By means of an air cylinder incorporated in it, pressures up to 400 pounds may be applied. While the doors are thus stressed, the car is driven over a rough Belgian block surface to wrench and weave the body structure.

DOOR TEST

A brace, similar in principle to the "air leg" sometimes used to support rock drills in mine stopes, puts a pressure of 400 pounds on car-door locks and latches. The instrument measures the pressure being applied.

Kemano Rodeo Drillers Compete for Cash



THE WINNER AT WORK

John MacDonald guiding his J-50 Jackhamer as it ate its way 10 feet into a granite cliff in a little less than 7½ minutes. He won a $300 jackpot.

A CASUALTY of our age of mechanization, hand-drilling contests have just about passed from the scene, but in many localities they have been replaced by machine drilling matches. And if anyone thinks all rock drills perform alike, the idea will be dispelled by watching one of these competitions.

An outstanding event of the kind was the feature attraction of an all-day "Miners' Rodeo" held at Kemano, British Columbia, one of the key points of the Alcan Project of the Aluminum Company of Canada (described in our August, September and October, 1952, issues). The rodeo lasted from 10 o'clock in the morning until 10 at night and the drilling contest consumed 4½ hours of the time.

Kemano is at the powerhouse end of a 10-mile tunnel that will deliver water for the generation of power to be used 50 miles away at Kitimat for the production of aluminum. A vast underground room has been hollowed out of solid rock for the generating equipment, and this excavation, together with the driving of the tunnel and auxiliary openings, has made the Kemano populace exceedingly rock-drill minded. In consequence, some 4000 persons gathered to watch the best drillers on the far-flung job do their stuff.

The rules governing the contest were a little different than those under which the old hand drillers vied. Instead of drilling for a set period—usually 15 minutes—the machine runners were timed while putting in a 10-foot hole. This included setting up the drill, changing steel three times and dismantling the drill set-up when through drilling. And, whereas the hand drillers pounded the steel into a vertical hole, which is the natural way for a man to swing a hammer, the Kemano contestants drilled horizontally into the sheer face of a cliff, which is the practice when driving tunnels and advancing horizontal mine openings. The rock was granite, thus conforming to tradition.

On a platform in the rear of the tunnel office, 20 of the best drillers on the project attacked the rock face, in turn, the order of appearance having been determined by lot. All were required to use drilling equipment furnished by the Department of Underground Excavations of the project contractor, Morrison-Knudsen Company of Canada, which limited it to the drills and accessories being regularly used on the job. They could have their choice, however, and 18 of the 20 entrants selected the Ingersoll-Rand combination of a J-50 Jackhamer on a JL-5 Jackleg support. This drill is used on the project chiefly in building roads and in excavating inclined raises for penstocks. The I-R drills that set records in the tunnel are of the heavier drifter type.

With three of the job supervisors—"Blackie" Primeau and John Sherlock, superintendents for two of the tunnel sections, and Bill Maloof, walking boss in the powerhouse area—serving as judges and two engineers comparing stopwatch readings, the skilled contestants put on a show that held the huge crowd's interest and frequently drew applause. At stake was a $300 cash prize, made up of entrance fees.

When it was all over, "Big John" MacDonald, from Cape Breton, Nova Scotia, representing the powerhouse drillers, was declared the winner and his time was announced as 7 minutes, 23.5 seconds. The runner-up was John Laresen of Winnipeg, from the 2600 Camp, 7 minutes, 27 seconds; and in third place was Allik Soar, 7 minutes, 31.1 seconds. All three used Ingersoll-Rand equipment.

Hajek Boris, a native of Yugoslavia and an entry of Horetzky Creek Camp, finished second in 7 minutes, 26.4 seconds, but was disqualified by the judges because he failed to conclude the test according to the rules. Two other contestants were ruled out because they drilled into holes that had been previously put there by other contestants. In all, 17 entrants completed their 10-foot holes according to regulations and all finished in less than 9 minutes.

SOME OF THE CROWD

All of the crowd of 4000 attending the rodeo spent at least part of the afternoon watching the drillers. Here they are looking at Walt Miekus, who completed his stint in 8 minutes, 8 seconds.

FLOATING DOWN THE RIVER

First of the eight caissons, with one tug forward and two alongside, begins the trip from its construction site to the bridge location ten miles downstream. Moving at 3 knots speed, it arrived at Tarrytown, N.Y., at 7:30 p.m. and was nudged into a 3-sided fender in approximate position for sinking. After it has been built up to its final height of 40 feet, the 16,000-ton structure will be lowered to the river bed by flooding its 24 compartments with water. Later, when the water has been pumped out, the buoyancy of the caisson will exert a lift sufficient to support 80 percent of the superimposed pier and bridge load.

Precast Pier Caissons Sunk in River

THE first of eight large reinforced concrete, watertight compartmented caissons that will support part of the weight of a 2.8-mile, 6-lane highway bridge across the Hudson River above New York City was towed ten miles from its construction site on October 12 and placed in position for sinking. The 16,000-ton box will, when lodged in its final resting place on the river bottom, become a part of the foundation for one of the piers of the 1200-foot central span of the bridge.

Under normal conditions, the footings for the piers would be carried down to rock or other solid material, but this was impractical in this instance because there is a layer of yielding silt from 230 to 300 feet thick on the stream bed. The caisssons will rest on this cushion, but will be pumped out and sealed to make them buoyant. It is estimated that their upward "push" will be sufficient to support 80 percent of the dead load resting on them. The other 20 percent will be carried on concrete-filled, 30-inch-diameter steel casings driven to resistance through wells in the caissons and then encased by concrete within the walls to pin the boxes permanently in place.

The principle of the compartmented caissons was developed during World War II for use in providing an artificial harbor for landing invasion forces on the beach of Normandy in 1944. The technique was originated by Emil H. Praeger, then a Navy captain and now chief engineer for Madigan-Hyland, engineering consultants to the New York State Thruway Authority, which is building the bridge across the Hudson between Nyack and Tarrytown as a part of the 427-mile Thruway route across the state.

The idea was first applied to peacetime construction in 1951 when three of the hollow caissons were embodied in the substructure of Pier 57 in the Hudson River in New York City. The scheme of building the big boxes up the river and floating them to their points of use was developed by the contracting team of Merritt-Chapman & Scott and the Corbetta Construction Company, and the same two firms are collaborating on the current undertaking. M-C & S has the contract for constructing 23 piers for the Thruway Bridge and its associate is building the caissons on a subcontract.

The plan became practicable through the fortunate existence of a worked-out clay pit bordering the Hudson River at Grassy Point, N. Y. Conditions were such that this could be readily converted into what has been described as the "world's largest dry dock." First the water was pumped out of the huge depression, which is about half a mile long, 600 feet wide and up to 42 feet deep. Then the bottom of some of the area was leveled and three caissons were built there in the dry, 30 feet below the level of the river. When they were completed, the pit was reflooded and the structures were floated. An opening was then cut in the narrow embankment between the pit and river and the boxes were towed out one by one for the 38-mile trip to New York.

Essentially the same procedure was followed in constructing the eight boxes for the Thruway bridge. The breach in the river bank was first closed and the pit pumped dry. A good part of the original construction foundations was used again, the work being started last January. Refilling of the drydock was begun on October 1 by admitting water through a valve-controlled 30-inch pipe extending through the bank from the river.

The two largest caissons, one of which was the first to be moved, cover half a city block in area, being 190x100 feet. Two others are 124½x77 feet and the four smaller ones are 110x56. Their base slabs are 28 inches thick. Exterior walls range from 45 to 56 inches thick. The hollow interiors are divided by reinforced walls into compartments, of which the two largest have 24, the two medium-size ones 12 and the four smaller ones 8. Weep holes connect the compartments, and each caisson has a sump from which any seepage can be pumped.

All will be built up to a height of 40 feet before being sunk to the river bottom, but they were constructed a few feet shallower at Grassy Point to make sure they would ride high enough to clear the river bottom while being towed. The initial one floated out was 35 feet high, with forms in place at the top for adding the final concrete at the bridge site from a floating mixing plant. It drew 27½ feet of water, and thus only its upper 7½ feet showed above the water line. Towed by three tugs, it moved down the river at 3 knots speed and was shunted into a rectangular fender system or "corral" that had been left open on one side to receive it. It was then maneuvered accurately into position and moored.

Once the last concrete lift has been added, the box's compartments will be filled with water to sink the structure to rest on a specially prepared 5-foot blanket of sand and gravel. As the water is 42 feet deep at mean low tide, the top of the box will be two feet below the surface. The coaming of a hatchway to the box will project above the water, providing means for pumping it out.

The steel piles previously mentioned will be driven through openings in the caisson lined with corrugated galvanized iron. The piles will be up to 270 feet long and will extend to bedrock. After being driven, they will be cleaned out and filled with concrete. Finally, the last of the water ballast will be pumped out to give the box its maximum buoyancy.

The eight caissons will form bases for piers of the central span, two flanking spans of 600 feet each and four spans towards the western end. The bridge, estimated to cost $60 million, will be 15,200 feet long and is scheduled to be opened to traffic in the summer of 1955.

Editorials

TALES OF EDISON

THIS year the spotlight of attention has been moved backward in time to focus upon Thomas A. Edison, this by reason of the fact that General Electric Company, which traces its lineage to the first of Edison's firms, is observing its 75th anniversary. Edison ushered in the age of electricity in 1879 by devising the first incandescent lamp. The key to that invention was a carbonized thread to form the filament. It was a simple thing, yet Edison tried 1600 other substances before meeting success.

The Edison Light Company, first of several concerns that were later merged to form General Electric, was organized on October 15, 1878, largely because a keen-minded New York attorney who represented Edison in a patent suit recognized that electricity had a bright future. He persuaded a group of New York financiers to chip in $300,000. Edison used most of it to enlarge his manufacturing facilities and kept $50,000 for working capital. In 1889 this firm and several others were united to form the Edison General Electric Company. It, in turn, joined with the Thomson-Houston Company in 1892 to create General Electric Company. Thomson-Houston had been founded in 1883 under the leadership of Charles A. Coffin, a New England shoe manufacturer. Coffin became the first president and Edison was on the board of directors.

Already, both Edison and Thomson-Houston had done much to popularize the new source of power. Edison had introduced his incandescent lamp to New York City in December, 1880, and in less than two years 900 buildings had been wired and 14,000 lamps connected to the circuit. Dynamos to provide the current had been set up on Pearl Street near the tip of Manhattan Island and eighteen miles of conduit strung under the streets. One day an excited, breathless young man burst into the generating room shouting that the electricity had got into the pavement in Fulton Street and set all the horses to dancing. This turned out to be true and it took several days to find the source of the leakage.

Edison was an exponent of direct current, while Thomson-Houston favored alternating current, and a spirited battle was waged for a time. The Edison people published advertisements warning the public that a-c was dangerous, and when the New York State prison adopted electrocution for capital punishment and decided to employ a-c, this was hailed as proof of the contention. In the end, of course, the Thomson-Houston viewpoint prevailed.

Because the G-E anniversary brings Edison back to mind, it seems a fitting time to record two stories of the great inventor. Neither tale is new, but probably few of the present generation have heard them. Both show something of the workings of the Edison mind.

The first one came from a man who worked in Edison's laboratory at West Orange, N.J., more than 30 years ago. He had recently been graduated from college when he went there and Mr. Edison soon decided to find out what kind of brain power he had. One day he handed the employee one of the old carbon-filament light globes and asked him to figure out the volume of space inside it. The youngster set about the task with the aid of all the higher mathematics he had absorbed in college, and after covering a good many sheets of paper with figures decided that he had come about as close to the correct answer as anyone could and handed it to Mr. Edison. The latter looked at it, said it was close but not quite right and told the boy to work on it some more. So back to work he went and eventually came up with a slightly different answer.

"You're still not exactly right," said Mr. Edison. "Here, I'll show you how to do it." Picking up the globe, he filed off the tip of glass that was formed on the old bulbs in closing them after the air was evacuated from the interior. He then weighed the bulb carefully on a delicate scale. Next he filled it with distilled water and weighed it again. Subtraction gave him the weight of the water and, knowing the temperature of the fluid, he was quickly able to calculate the number of cubic inches it occupied, which was the answer to his question. "See how easy it is," was his parting word of advice. "Don't make something hard to do if there is an easy way."

The second story concerns a Cumberland, Md., customer of one of Edison's concerns which was burning out armatures rapidly and complaining about it. The man Edison sent to investigate the matter found a colored attendant who said, in reply to a question, that he determined when dynamos were carrying too much current by feeling the wires to find out how hot they were.

Upon getting this report, Edison said: "We have got to get up an ammeter." His engineers set to work, and in about a week had devised the old Edison pendulum ammeter. When the first sample was shown to Edison he said it was pretty good, but wondered if it would stand rough treatment.

"Have six of them made up," he ordered. "After you have examined them in the testing room, have them packed and then call me."

In a little while he was notified and came in. Edison said, "Put them on the table," and this was done. "Now get up on the table and kick 'em off; if they won't stand this, they will never reach Cumberland in operating condition."

They were kicked off the table as hard as the fellow could kick them and sent spinning over the floor. Edison then said: "Now I will look at them." After a careful examination they were approved for shipment.

THE GREAT TRANSFORMER

THE bulldozer and large companion machines that are utilized for the mass shifting of earth, have wrought wonders in such operations as clearing land, excavating, building highways and extracting ore and coal from open pits. The 'dozer is essentially a simple contraption—little more than a blade of tough steel mounted on the front of a tractor. It is the push of the tractor, of course, that does the business.

A bulldozer shoving around huge, jagged rocks resulting from a blast on a road-building job in mountainous terrain is a thrilling sight to behold. Sidewalk superintendents of city construction jobs rarely experience this treat, for the 'dozer's domain is the wide-open spaces. The driver, generally called a skinner—a term that came down from the days of mule-drawn pygmy scrapers—apparently knows no fear as he pilots his juggernaut shakingly but surely over a forbidding path. In a matter of minutes he makes molehills out of miniature mountains.

Largely because of this marvelous machine, numerous jobs that were once too costly to contemplate have become practical. With its aid, eyesores created by gashing the earth's surface to get at buried mineral can be healed, thus removing one source of criticism of such mining operations. In the Alabama mountains, for instance, Republic Steel Corporation has just restored to even surface fourteen acres of land that it tore up to extract 300,000 tons of iron ore. As the tract is alongside a main highway, the public had strongly disapproved of its conversion to an ugly field of rocks.

In response, Republic put a fleet of bulldozers to work, pushing the mounds into the hollows, covering the bare stones with earth and restoring the original contour of the mountainside. Honeysuckle vines are being planted and rye grass will come next. Before the year ends the planting of 17,000 pine seedlings will begin. Nearby residents who led the outcry against the havoc and confusion produced by the strip-mining are beginning to admit that the landscape will probably look better in a few years than it did before it was torn up.

Concrete Blown Quarter Mile Underground

A PUSH-BUTTON system of blowing concrete by compressed air through piping from underground mixing stations into construction forms is expediting The International Nickel Company's program of mining by induced caving at its Creighton Mine, Copper Cliff, Canada.

To stabilize areas of the mine worked and abandoned 40 or more years ago and to utilize old openings in which the timber supports have rotted and collapsed, extensive concreting is necessary. Very slowly and often only with the greatest difficulty could concrete be delivered to these locations before the airborne system was adopted. Several thousand bags of cement a month are now being used underground to build slusher stations and drifts, box-hole brows, switchrooms and other installations required to meet the caving project's quota of 12,000 tons of ore per day.

Concrete mixing stations located on the 6th and 20th levels receive gravel by gravity from the surface through a raise formerly used for bringing rock fill to the various levels of the mine. Control chutes in the raise handle the gravel at each station. Cement is brought down by the mine's regular transportation system.

Located in large rooms that provide ample space for cement storage, the mixers can produce a 16-cubic-foot batch of concrete every three minutes. It is poured into the placer, a cylinder 2½ feet in diameter by 10 feet long, into which compressed air is then introduced from the mine's main air line.

From the placer the concrete is blown through a steel pipe 6 inches long which carries it along levels, up or down manways, and through twists and turns of the mine's workings until finally, perhaps a quarter of a mile or more from the mixing station, it drops into the forms at the construction site.

At 90-degree turns in the line T-bends are used; an air cushion that forms in the dead end of the T greatly reduces abrasion from the concrete. On long curves are inserted sections of 8-inch pipe with Ni-Hard liners. Standard steel elbows last as little as two hours under the impact of the concrete at these turns; but the liners, made of a very tough nickel alloy are little changed after six months of operation.

The men operating the concrete placers take pride in the remarkable performances recorded to date. Best delivery above the starting point so far was a total of 1315 feet from the 20th-level placer, consisting of 875 feet on the level, up 210 feet on a 47-degree incline, 100 feet on the level, up 50 feet at 90 degrees, and finally 80 feet on the level. The 6th-level station made the longest "down" delivery to date, a total of 1670 feet from the placer into the forms for a new slusher station on the 14th level.

Inflatable Shaft for Paper Rolls

THE Aero Shaft slips through the hollow core of a roll of paper and is then inflated with compressed air, which causes it to grip the inner walls of the core firmly and evenly. It is produced by Paper Converting Machine Company, of Green Bay, Wis., for use in

place of older appliances such as tapered core plugs, wedges and screw devices that frequently cause damage.

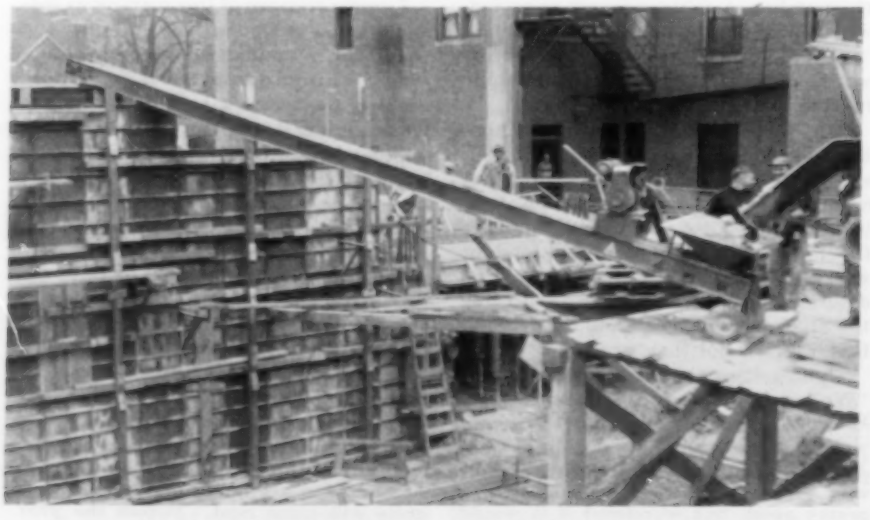
It consists of a sturdy steel tube of 2-inch external and 1-inch internal diameter and is of a suitable length to meet the needs of the roll it is to serve. Drawn over this steel member is a neoprene-rubber tube secured at each end by a hose clamp. Eight longitudinal steel ribs or springs, held in place at their ends by steel collars, complete the assembly.

Air admitted at one end through an ordinary automotive-type valve expands the rubber tube and presses the steel ribs firmly against the inner surfaces of the roll. Tests indicate that a pressure of 5 psi is sufficient to hold the shaft in a roll 40 inches in diameter without slippage between it and the core. In other tests, an assembly was inflated and deflated 72,540 times without failing. This is estimated to be equivalent to approximately twelve years of normal service.

EASY TO APPLY

Compressed air expands the neoprene tube encased in steel ribs, pressing the latter against the core and holding the shaft securely until it is deflated.

A shaft can be inserted in a few seconds, inflated in 3 seconds and deflated instantly by operating a release valve. As it does not damage cores, the latter may be reused many times. Aero shafts are currently available for use in standard 3-inch-internal-diameter cores of rolls having widths from 10 to 80 inches. For those with widths exceeding 40 inches, a double set of ribs is employed with a collar between the sections.



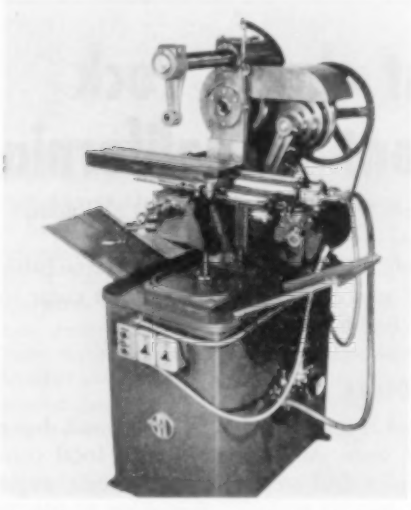
PORTABLE CONVEYOR FOR CONSTRUCTION JOBS

Called the Con-vay-it, this portable materials mover consists of a 12-inch-wide neoprene belt driven by a Wisconsin gasoline engine and housed in a channel-iron boom. It comes in either 20- or 30-foot lengths. Although designed primarily for handling concrete, which it will transport at a rate of 1 to 3 cubic yards per minute, the device will also carry bricks, lumber, gravel and various other building materials. American Conveyor Company, Chicago Ill., is the manufacturer.

Industrial Notes

Field experience has shown that reinforcing the edges of coal-mine conveyor belts with tough rubber protects them from the heavy wear to which they are subjected in that service. United States Rubber Company has announced that it is increasing the life of its Giant belts by capping the edges with rubber of special construction.

For production milling, Rotex Punch Company, Inc., has introduced a semiautomatic machine that is said to insure greater than normal output through rapid approach, widely varying cutting



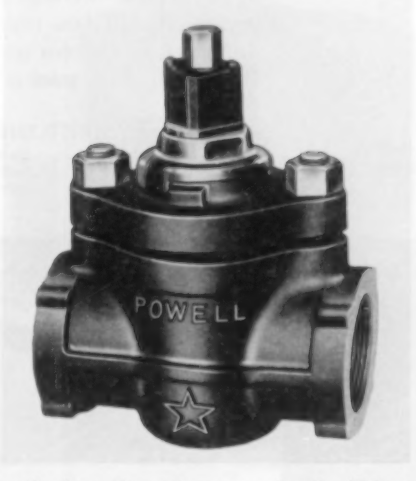
speeds and automatic return. It has a spindle of large diameter that permits the use of any one of three spindle bores: Nos 9 or 10 B&S or No 4 Morse taper. All models are equipped with Bellows feed and Hydrocheck air cylinders and are available with 2- or 3-slot tables.

Tiny screws, nuts, bolts, etc., for assembly work are hard to pick up with the fingers but not, we are told, with tweezers designed by Win Sales Company. The gadget looks like a fountain pen and has a clip to keep it in the pocket when not in use. At one end is a plunger which, when pressed, causes three steel prongs to flare out at the tip. When pressure on the piston is released, the fingers will grasp and hold oddly shaped objects and make it possible to put them in otherwise inaccessible places. The instrument is made of stainless steel.

Measuring dry bulk materials such as grain, flour, chemicals, etc., flowing down through a pipe at the rate of 25 to 225 pounds per minute is simplified, it is claimed, by a Massometer designed by Wallace & Tiernan Company. The unit, with a 5-inch opening top and bottom, is interposed in the line and contains a horizontal disk mounted on the shaft of a vertical motor. As the granular material passes through the pipe it impinges against the disk, the load causing the motor housing to rotate. This reaction depends upon the rate of flow and is metered by a pneumatic relay which transmits the measurement to a standard Brown pneumatic pressure recorder. The chart is calibrated to read in pounds per minute. Accuracy is said to be within 1 percent, plus or minus.

Instead of digging blast-echo "mike" holes by hand, as has been the practice, oil-exploration crews now do the work easily by a portable tool that penetrates either hard or soft ground or shale. It consists of a shaft with vertical cutting blades at the bottom operated by an air or electric drill mounted at the top. There are two models for excavating 6-inch holes 3 and 6 feet deep, respectively. Deeper holes can be drilled by use of a shaft extension.

The William Powell Company is offering industry a new line of semisteel and steel lubricated plug valves that are characterized by quick and positive shutoff. All are wrench operated and require only a quarter turn to open or close them. Lubricant grooves surround each port and are said to provide a positive



seal when the valves are closed. When open, the seating surfaces are not exposed. Those of semisteel are available for 175 and 200 pounds W.O.G. and those of carbon steel for 150 and 300 pounds W.P. They are made with screwed or bolted glands.

Mass-produced ammunition can be inspected with precision at the rate of 3600 rounds an hour, it is claimed, by an automatic gauging machine recently developed by The Sheffield Corporation. It simultaneously checks profile and alignment, head to shoulder dimension, overall length, extractor groove, primer depth

and head diameter and thickness, while at the same time separating the cartridges into four classes: acceptable and rejects, the latter for dimension, overweight and underweight. The weighing device is of new Sheffield design and functions pneumatically. The unit is operated by a push button and has two hopper-fed split-chamber gauging stations. Individual lights on a diagram panel, one for each dimension or condition, indicate whether the ammunition is acceptable or plus or minus.

With only two moving parts, an improved regulating valve introduced by Airmatic Valve, Inc., is said to permit the operation of two or more cylinders in proper sequence and the control, with one main valve, of many work stations using air, oil or water. Operating pressure ranges from 20 to 200 psi. The unit has a body of cast naval bronze and straight-through piping. Designated as Series SQ, it is available in six standard pipe sizes from ¼ inch to 1¼ inches.

Under the name of Qua-Flex, Quaker Rubber Corporation is marketing a new air hose of 3-part construction for pressures up to 450 psi. It has a nonporous rubber tube to withstand oil and heat, a horizontally braided rayon carcass reinforced with cable cord and a wrapped rubber cover to resist abrasion, weather checking and oil. It is made in lengths up to 50 feet and in ⅜- to 2-inch diameters.

Wilkerson Corporation has announced that its Series 1070 float-operated sump drains and moisture separators have been simplified mechanically and now incorporate a leakproof cast-aluminum float. The drain automatically discharges water and sludge from line sumps, tanks and aftercoolers, and while it is actuated by the collected contaminants, drainage is actually effected by air pressure in the sump or tank to which the unit is attached. The float instantly releases the

Lead-Zinc Mining In Utah—Bethlehem Hollow teams up with carbide-tipped bits on the 1500-ft level of the Mayflower Mine of New Park Mining Co. This jumbo-mounted drifter puts in 6-ft holes through abrasive sulphide ore bodies.

Dam Building in Northwest—Excavating work at the site of Chief Joseph Dam on the Columbia River called for more than 100 tons of Bethlehem Hollow. This is a recent addition to the long list of big projects where this "old reliable" of drill steels has had the responsibility for keeping drilling on schedule.

Buffalo Underpass Job — Rock drilling doesn't stop for chilly weather in Buffalo. Here Bethlehem Hollow bores into hard, flint-streaked rock on an excavating job that removed 70,000 cu yd of rock on a four-lane underpass contract.

Steel that chews rock from Vermont to California

Deep-holes, short-holes. Hard, abrasive ore . . . basalt . . . dolomite. Steel bits . . . bits with carbide inserts.

Whatever the depth of hole, type of rock, or style of detachable bit, there's one hollow drill steel that does the job from coast to coast, and does it well. It's Bethlehem Hollow.

Make sure you've got this old reliable on the job!

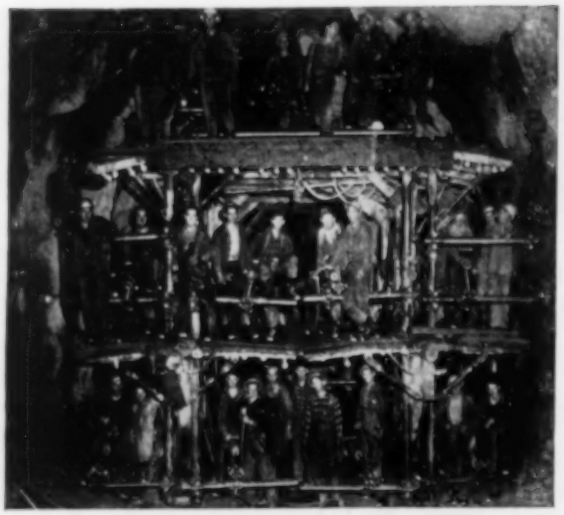
IMMEDIATE DELIVERY

Bethlehem Hollow Drill Steel is ready to ship from our mill depot in all popular sections and sizes. Also available from local converters. And if you need solid drill steel, quarrying steels, auger drill steel, or steel for stone-dressing tools . . . remember to specify Bethlehem. Each steel is engineered to give a lot of service.

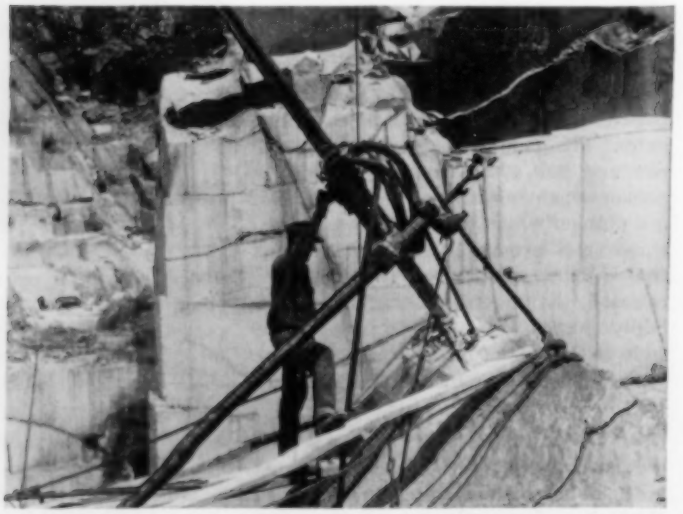
BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

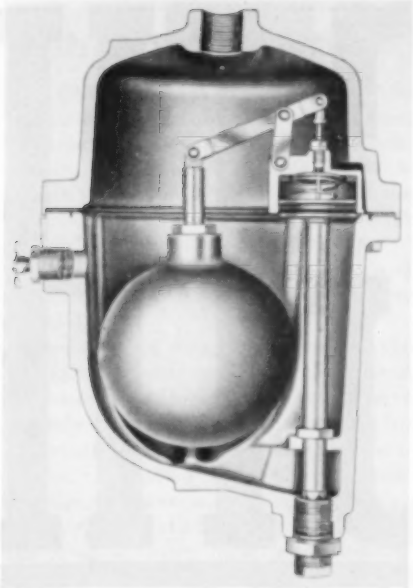


California Tunnel Project—Here's the three-story drill carriage and one of the crews that smashed three records for driving large-diameter tunnels. Big Creek Project No. 4 was the scene of this outstanding performance of Bethlehem Hollow.



Quarrying Vermont Granite—A real test of drill-steel quality is provided by "Rock of Ages," a hard, dense-grained granite. This rock drill, using Bethlehem Hollow, is mounted on a movable saddle so that a line of holes can be drilled in perfect alignment. Quarries everywhere rely on Bethlehem Hollow.

BETHLEHEM HOLLOW DRILL STEEL



accumulation by means of a patented air device that opens the port in the bottom. Drainage capacity exceeds 250 gallons an hour, but the unit can be made of well-nigh unlimited size. The drain is also a part of Wilkerson's automatic separators for ½-, ¾-, 1- and 2-inch air lines, interrupted or continuous flow. These models contain a condensation chamber and filter to produce large volumes of clean, dry air with no significant pressure drop.

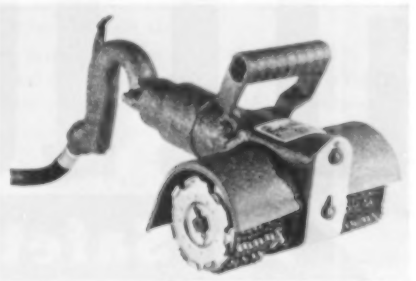
Handling bulk materials under high pressure or vacuum in the chemical and process industries is made possible, it is claimed, by a new rotary-feeder air lock designed by Beaumont Birch. This is largely accomplished by means of a seal at each end of the rotor. It is made of rawhide, neoprene, asbestos or Teflon, run dry or lubricated, and may be spring-mounted. Further assurance against leakage is obtained by injecting an inert gas under pressure between the ends of the rotor and the casing. This is important where noxious gases are involved in a process. The shaft is also sealed. The feeder is available with six and more pockets in cast iron, stainless steel or monel.

Four sizes of strainers designed to fit various makes of paint-spray guns are being manufactured by the Clear-flo Strainer Company. The small attachment slides over the intake tube of the gun, where the fine-gauge brass screening prevents fouling of the nozzle or spattering of the paint by keeping out slugs and impurities. It is said to insure a smooth paint job from start to finish.

A plastic material recently announced by The Reed Research Foundation is said to expand considerably during reaction and to trap many small air bubbles. As it foams, it hardens, a state in which it has a buoyancy from 50 to 100 times its own weight. A person overboard, for example, could break a small tube of the plastic and thus fill his clothing with foam that would set and keep him afloat. The same procedure could also be applied to flooded ship's compartments and to aircraft forced down at sea.

For the cleaning of steel decks, tanks, girders or other surfaces, the G.H. Tennant Company has developed a hand-wielded rotary chipping tool that removes rust, scale, paint, ice, glue, chemical deposits and other material from 12 to 20 times faster than the work can be done by hand scraping.

Its divided, 9-inch-long cylindrical head has 102 hardened steel teeth projecting from it. When revolving at the top speed of 12,000 rpm, they strike more than 3000 times per second and clean 100 square inches of surface with each 25-inch pass. With the tool, the manufacturer claims, metal surfaces can



be prepared for painting for about 40 percent of the cost of other mechanical methods.

Called the Revo-Tool, the machine is normally powered by an Ingersoll-Rand ¾-hp air motor. Designed for 1-man operation, it weighs 16 pounds and has a sheet-steel hood that protects the user against flying chips.

"His name's Mohammed."

WISCONSIN-POWERED
HEMCO-MOTIVE
Switching Unit
Moves 3 Cars at a Time!

Here's a practical "locomotive" for switching and spotting cars on your sidings — at a great saving in man-hours, plus increased safety and ever-ready convenience . . . at an operating cost of about 1½ gals. of gasoline per hour!

A 25 hp. Model VF4 Wisconsin Heavy-Duty Air-Cooled Engine furnishes dependable power for all phases of HEMCO-MOTIVE operation . . . off-track mobility, climbing up and over the rails, operating the hydraulic lift that "couples" the unit to the car, and handling all switching and spotting maneuvers . . . delivering a 7400-lb. drawbar pull through 4-wheel drive, moving up to 3 loaded freight cars at a time, at a rail speed of 150 ft. per minute! Hemco Manufacturing Inc., Argonia, Kansas, is the builder.

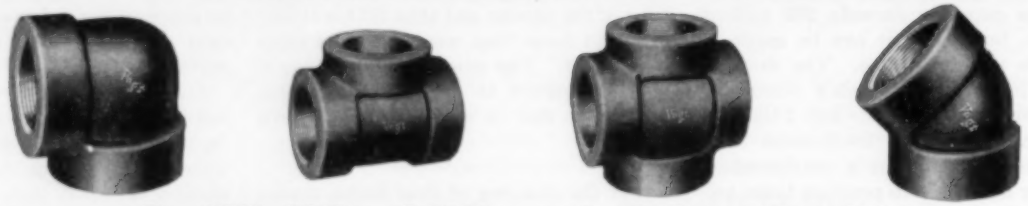
It's another typical Wisconsin Air-Cooled Engine original equipment application . . . again illustrating how these fine engines fit both the JOB and the MACHINE.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

A 7550-½

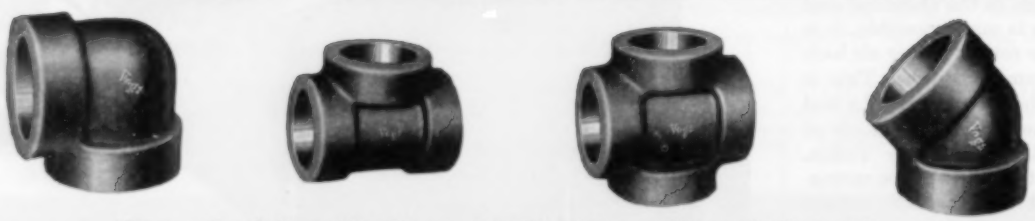
STRENGTH

for Safety and Long-Time Service



For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SCREW END TYPE



For schedules 40, 80 and 160 pipe — Sizes 1/8" to 4"

SOCKET WELD TYPE

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-9 will aid you in their selection and proper application.

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy in steam plants, petroleum refineries, chemical plants and related industries.

HENRY VOGT MACHINE CO., INC.
Louisville 10, Kentucky
BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

Vogt

DROP FORGED STEEL FITTINGS

Clinchfield Railroad Washes Its Tunnels

FOR the first time, it is claimed, the walls of railroad tunnels have been systematically washed to remove soot, fly ash and grime. The work was done during three days in August on the Clinchfield Railroad, which extends for 277 miles from Elkhorn City, Ky., to Spartansburg, S. C. All of the line's 55 tunnels, totaling 9.7 miles in length, were cleaned.

The washing was done to reduce the amount of attention that has to be given the road's diesel locomotives, which have entirely supplanted in through trains the steam traction units formerly employed. Excessive engine filter and ring maintenance was encountered. When an investigation indicated that much of the offending abrasive material was being dislodged from the accumulations on the tunnel surfaces, Clinchfield officials decided to remove it.

After 40-odd years of use, the steam locomotive had left its mark. The crown sections of the bores were coated with a deposit of soot, fly ash and sand dust from one to three inches thick. The horizontal crevices in the rock walls of unlined sections were well filled. Ever since diesel engines have been in service, they have disturbed some of this powdery stuff because they generally run through the tunnels under full power or under full dynamic braking. Air from cooling fans, brake blower fans and exhausts, as well as the swirling currents created by the passage of the trains, dislodged some of the dirt. A portion of it got through the filters into the engines and much more of it eventually wound up in the road's filter-cleaning department.

The tunnel-cleaning job was allotted to Spray Services, Inc., a Huntington, W.Va., concern that sprays railroad roadbeds and rights of way to kill weeds, brush and grass (described in C.A.M., June, 1951). The same equipment, consisting of pumps, nozzles, etc., mounted on right-of-way spray cars, was utilized for the washing service. The work train was made up of a diesel locomotive, a spray car, ten tank cars each containing 8000 gallons of water, two boxcars and two cabooses. The extra caboose carried the clothes and luggage of guests and the spray crew. The boxcars were equipped with sloping skirts along the lower edge of the side sheets, and these extended outward 2 feet to deflect the falling water and dirt into the ditch line to prevent fouling of the ballast. Each of the spray car's two pumps delivered 325 gpm of water to the nozzles under 180 psi pressure. Additional water was obtained, as needed, from tanks along the railway.

The cleaning was started at Marion Tunnel, which is 1073 feet long and concrete-lined. The first trip through was made at 10 miles per hour with the spray nozzles set perpendicular to the tunnel walls. The results were disappointing because the sprays packed the dirt against the walls, and the train speed was too great to be effective. The nozzles were then set at a 60-degree angle to the walls and the train sent through again, this time at 4 miles per hour. This arrangement produced better results, and subsequently the train made three trips through each tunnel.

Sandy Ridge Tunnel, 7854 feet long and concrete-lined, was found to harbor the heaviest deposits. Double-heading steam locomotives pulling trains up its 0.5-percent grade over the years had left large quantities of dirt. It was consequently decided to make one trip through the bore with the cleaning train and let it rest overnight. This did not prove to be of any value, as the dry dirt and concrete soaked up the water and it was found necessary to make three trips the next day to dislodge the sludge. It was estimated that four tons of material was washed from this one tunnel and almost proportionate quantities from the 54 other bores. There are still some spots of dirt in some of them, but they are soaked with grease and oil and

HEAVY DUTY
PRESSURE SWITCH
FOR AIR COMPRESSORS
Class 9013 Type ASG Form X
Cutaway view of valve
COMPLETE RANGE IN 1 CONTROL UNIT
Either 20 to 180 or 25 to 250 PSI. No spring changes required.
MORE AIR CAPACITY
with improved 2-way ball and "O" ring type valve.
Write for Bulletin 9013A. Address Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin
ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS
SQUARE D COMPANY

FOR BETTER SERVICE specify...
COOK
ROD PACKING RINGS
STYLES FOR EVERY COMPRESSOR SERVICE
DELIVERY FROM STOCK
MATERIALS FOR EVERY CONDITION
Cook Graphitic Iron Plain or Tinized • Cookmet (Bronze) • Babbitt • Carbon • Cookroc (Bakelite) plain or graphitized • Hi-Temp Cookroc (Bakelite)
Write for Catalog No. 440
C. LEE COOK MFG. CO.
INCORPORATED
Dept. 1, LOUISVILLE 3, KY.

it is believed they will cause no trouble.

The experiment developed considerable knowledge that will be of benefit in any future undertaking of the kind. It was agreed that a higher water pressure than was available is required and that the arrangement of spray turrets on the conventional brush-spray car is not well suited to this operation. Proper-type nozzles in the right places and more pressure will increase the efficiency. It is believed that the cleaning can be carried on concurrently with brush or right-of-way spraying by stopping at a tunnel portal, clamping nozzles in position, shutting off the supply of chemical, increasing pumping pressure and spraying the tunnel walls with water only.

Clinchfield engineers estimated that at least 3.4 percent greater engine piston-ring life should be realized as a result of the tunnel scouring. Such a saving would exceed in one year the cost of the washing, and any further increase in ring-life expectancy would be reflected as a net saving. Filter benefits will also almost certainly be derived, but no attempt was made to place a monetary value on them. The washing has, moreover, made it easier for the maintenance-of-way department to scale the rock walls of the unlined tunnels, and the removal of acid-bearing dirt will lengthen the service of rail and track accessories.

L.T. Nuckols, chief engineer, and L.L. Shirey, bridge engineer of the Chesapeake & Ohio Railway Company went along by invitation to observe the operations, being interested because their railroad also has many tunnels. Representatives of the Clinchfield road in the party were J.M. Salmon, Jr., chief engineer; Van B. Elliott, retired chief engineer; W.C. Hillman, master carpenter; P.M. Britt, assistant trainmaster; W.A. Baker, general diesel supervisor; and W.L. Stultz, assistant trainmaster. Also along was T.B. Powell, manager of the construction equipment department of Banks-Miller Supply Company of Huntington, which sold some of the equipment used. When a young man, Mr. Powell served as one of the engineers that laid out and built the Clinchfield line through extremely rugged terrain.

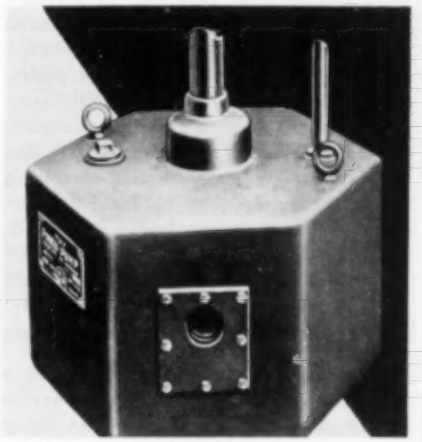
"Guess it's one of those government housing projects we hear of."

MOVING DAY FOR LAKES

Getting rid of water in mining operations is no problem with Naylor pipe on the job. This distinctive lockseamed, spiralwelded pipe provides extra strong, light-weight lines that are easy to handle and install, yet plenty tough for rugged service like this. For moving water or moving air, you can't top Naylor pipe. Ask for Bulletin No. 507.

NAYLOR PIPE COMPANY
1245 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, New York

For handling heavy fluids such as brine, oils, mud, sludges, molten metal and molasses, to list only a few, Yeomans Brothers Company has added a new model to its line of pneumatic ejectors that is said to operate with high efficiency even though the rate of flow is low. Called Pneu-Pump, it has only one moving part—a ball or nonreturn inlet valve. Operation is simple: the liquid enters the body of the unit until overflow rises in a pipe and seals it to atmosphere. This causes compressed air



to build up pressure inside the body to eject the contents through another pipe and thus to reopen the sealing member. The pump is made of stoneware to resist high temperatures, or of cast iron either plain or with a lead or rubber lining suitable for handling acids or other corrosive fluids.

QUOTES

—FROM HERE AND THERE

Tube-jam Detective

"Paris, famous for the speedy delivery of letters through pneumatic tubes, should find radioactive materials handy for maintenance of the system. *Ohmite News* reports that a bit of radioactive cobalt on the carrier enables a Geiger counter to locate a jam speedily."

Science and Appliance, Ohio State University, September

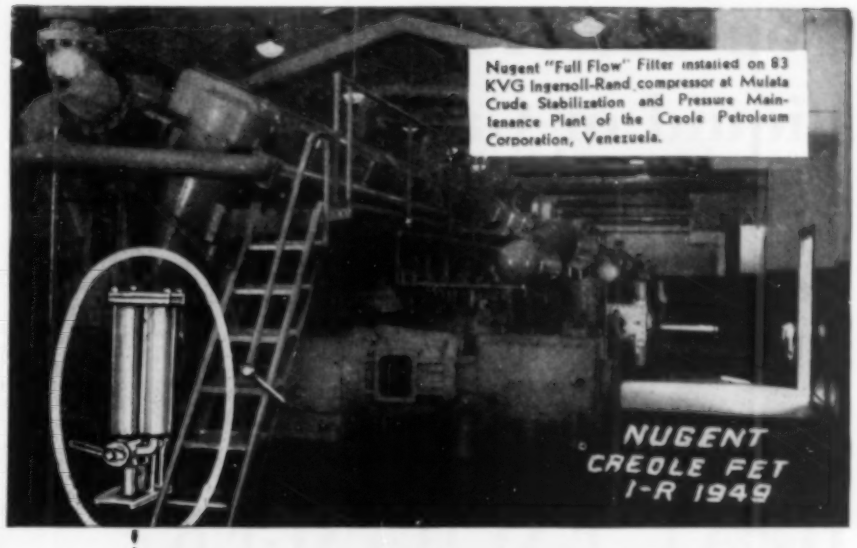
Messages by Air

"A ¾-mile-long pneumatic tube for express-message conveyance has been installed in Stockholm between two main telegraph offices. The compressed air which is used as the transport medium is cooled down to a temperature which is always lower than that of the surrounding air or water so as to avoid condensation in the tube."

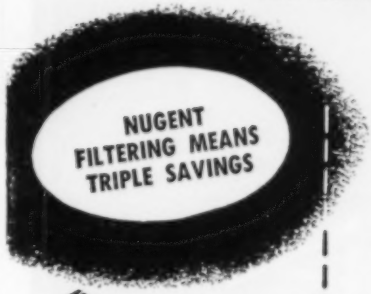
The Swedish-International Press Bureau

Progress in Australia

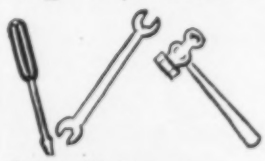
"During the year new drilling equipment and tungsten-carbide bits have been almost universally introduced into


Nugent "Full Flow" Filter installed on 83 KVG Ingersoll-Rand compressor at Mulata Crude Stabilization and Pressure Maintenance Plant of the Creole Petroleum Corporation, Venezuela.
NUGENT
CREOLE PET
1-R 1949

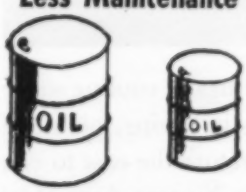
● DON'T OVERLOOK THIS CRUCIAL POINT IN COMPRESSOR OPERATION



Longer Machine Life



Less Maintenance



Less Oil Replacement

IT'S the lube oil filtering system, and it can play a big part in your profit and loss statement.

If you put a Nugent "Full Flow" filter in that spot you can be sure of stopping 99.8% of the harmful impurities that get into lubricating oil before they reach the vital working parts of the compressor. This is the kind of filtering that pays for itself many times over in oil savings, increased equipment life and reduced maintenance.

In Nugent "Full Flow Filtering" all the oil being circulated through your equipment is filtered every cycle. No part of the contaminated oil bypasses the filter. Dirt that is removed from the oil collects inside the special Nugent filter bags. When these bags fill up they can easily be cleaned and reused or new replacement bags are inexpensive. In addition, Nugent filter bags have 20 times more filtering capacity than others of comparable size.

Whatever type of machinery you use — compressors, gas engines or diesels — Nugent Filters can answer your filtering problems. There is a size and type for every need. Write for complete details.

Wm. W. Nugent & Co., Inc.

422 N. Hermitage Ave. CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Established 1897

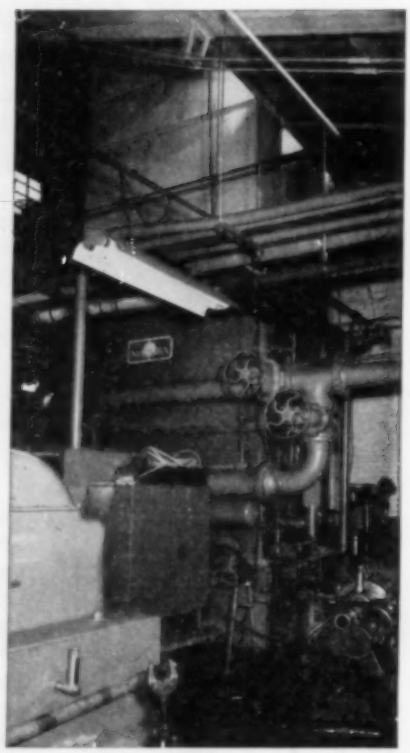
Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

You Get Trustworthy Liquid or Gas Cooling With Great Cooling Water Savings from the NIAGARA AERO HEAT EXCHANGER

● You can cool air, gas, water, oils, chemicals, electric and power and process equipment, engines, mechanical processes with lower cost and really accurate control of temperature with the Niagara Aero Heat Exchanger.

You are assured of uniform, constant production and quality from any process . . . steady, reliable operation . . . lower cost for more dependable cooling. You can have closed system cooling with freedom from scale, dirt, corrosion and maintenance troubles. You can accurately cool more than one type of liquid with one machine.

The Niagara Aero Heat Exchanger uses atmospheric air to cool liquids and gases by evaporative cooling. You can remove heat at the rate of input to keep accurate control of gas or liquid temperature. You can put heat back into the system to save the losses of a "warm-up" period or to equalize the effect of load variations.



Great savings in cooling water and savings in piping, pumping and power return the cost to you quickly. The Niagara Aero Heat Exchanger can save you approximately 95% of your cooling water cost. Write for Bulletin 120.

NIAGARA BLOWER COMPANY

Over 35 Years Service in Industrial Air Engineering

Dept. CA, 405 Lexington Ave. **New York 17, N. Y.**

Experienced District Engineers in all Principal Cities of U. S. and Canada

the mines in Western Australia with very beneficial results to all companies and also to the men operating the machines, who have been relieved of the burdensome task of handling heavy equipment."

R. J. Agnew, president, annual meeting of The Chamber of Mines of Western Australia

Forging in Midair

"Principle of the Chambersburg Impacter (air-operated horizontal, automatic forging unit described in C.A.M., January, 1953) now being used to make jet engine blades, soon will be extended to forging of scissors, hand tools, pliers, etc. Parts will be automatically conveyed through Selas gas-fired furnaces to the Impacter. Provisions are also being made to forge ferrous metals in reducing atmospheres to control scale. Another application being explored: Forging titanium in inert atmospheres."

Steel Magazine, August 31

Air Stream Separates Particles

"Particles so fine that more than a thousand could line up single file across the head of an ordinary pin are being separated by a device developed by General Electric Research Laboratory, Schenectady 5, N.Y. Without using any wire screen, the powder is blown upwards through a vertical seven-foot glass tube. At first only the finest particles (.0001" diameter) reach the top and are removed. Afterwards the air velocity is increased and larger grains (from .0001-.0002" in diameter) are collected."

Chemical Processing, June

Plastic Solves Roofing Problem

"A sprayed-on plastic skin was the solution to the tough roofing problem presented by the need to resurface the sharply pitched gables of the 40-story

"Just look at these bills! Rent, light, salaries, taxes. We've got to stop all this wild spending."

Sherry-Netherland Hotel in New York. Progressive Industries, Inc., of Long Island City, N. Y., sprayed 500 gal. of vinyl resin-based coating over 10,000 sq. ft. of surface to waterproof it. In addition, seams and joints were calked with plastic compound."

Engineering News-Record, July 23

Mobile Stock Bins

"To eliminate time lost by personnel traveling between their work stations and the central stock crib on the Convair-Liner primary assembly line, Convair's San Diego division has developed mobile stock carts which take parts to the employees.

"Instead of serving the employee through an issue window, personnel in the stock crib fill mobile parts racks which are wheeled into the assembly areas. These 'serve-yourself' units each contain a kit of parts made up of the exact number of items required at a given station for a given period of time in the production schedule."

Plant Engineering, August

Air Locomotive Saves

"Substitution of a two-speed air locomotive and 3-ton automatic dump car for hand tramming methods at the Copper Mountain Mine of Granby Consolidated, British Columbia, resulted in labor savings of 26 percent. The locomotive is a 3,260-pound unit, equipped with a 58-cu-ft receiver and 7½-hp air motor . . . . Charging the locomotive is accomplished by using an automatic shut-off quick-change valve. Charging stations are spaced about 600 feet apart. Usual charging time is about 40 to 60 seconds, depending on the tank pressure. The auto dump car is a 50-cu-ft side dump . . . . Two 8-inch cylinders, one on each end of the car and controlled by the motorman, dump it."

Engineering & Mining Journal, August

"Oh! I'm for incentive plans as long as they don't try to get us to work harder."

BEST ALL-AROUND PLAIN END PIPE COUPLING ON THE MARKET!

HERE'S WHY . . . *The Roust-A-Bout grips (teeth) take a strong, positive, circumferential bite on the pipe—as does a Tubing or Pipe Slip. The curved grips assure maximum gripping area for greatest holding power. This is the exclusive Roust-A-Bout, bull dog grip.*

Why accept less than the best when you are using plain end pipe couplings? Victaulic Roust-A-Bouts are specially engineered to provide the most reliable pipe connections you can use. With inclined, curved grips they bite into pipe circumference—provide a far stronger and surer hold.

Roust-A-Bout Couplings are just what the name implies—reliable, sturdy, adaptable and ingenious—ready for those tough field jobs where only plain end pipe is used or where the simple Victaulic Groove Method is not quickly available.

Victaulic Roust-A-Bouts are quick and easy to install: . . .

- You *cut* and *couple* your pipe as you go!
- You can use *plain* or *beveled end* pipe!
- You can use *new* or *used* pipe!
- For use on *permanent* piping or *repair* work!
- You need only one tool—a *socket wrench!*
- Roust-A-Bouts are simple and factory finished!

For your next job—insist on the best—Victaulic Roust-A-Bouts. They're available at all Victaulic Stocking Supply Houses in pipe sizes—2", 2½", 3", 3½", 4", 5", 6", and 8".

Write today for the Victaulic Roust-A-Bout Catalog No. 44-8B

VICTAULIC COMPANY OF AMERICA • **P. O. BOX 509** • **ELIZABETH, N. J.**

Office and Plant: 1100 Morris Ave., Union, N.J. • Telephone Elizabeth 4-2141
West Coast: Victaulic Inc., 2330 East 8th St., Los Angeles 21
Canada: Victaulic Co. of Canada Ltd., 406 Hopewell Ave., Toronto 10
Export: Pipe Couplings, Inc., 30 Rockefeller Plaza, N. Y. 20, N. Y.

Industrial Literature

Dangers Under Pressure is a safety booklet that was prepared by Hose Accessories Company, 2700 N. 17th Street, Philadelphia 32, Pa., to help users especially of air, gas or steam hose avoid accidents. It lists a series of "Do's and Don'ts" which, if followed, will go far to insure safe couplings.

Dayton Rogers Manufacturing Company, Minneapolis 7, Minn., is distributing a 24-page brochure describing how precision die-cut stampings are produced in small lots by a process patented by it. Requests for the publication should be written on company letterheads.

RLM Standards Institute, 326 W. Madison Street, Chicago 6, Ill., has announced the 1953 edition of RLM Standards Specification book—a reference work on industrial lighting equipment for architects, electrical contractors and others concerned with illumination. It has been completely revised, includes new data, and is easier to use than past issues. Complimentary copies are being distributed by the Institute or by member lighting-equipment manufacturers.

Powermaster packaged automatic boilers in seventeen sizes from 15 to 500 hp for process or for comfort heating at pressures up to 250 psi are described by Orr & Sembower, Inc., Morgantown Road, Reading, Pa., in its newly released Bulletin 1219. It contains typical installation pictures, drawings and cutaway views, as well as data on firing equipment for light and heavy oils and on gas and control systems.

Catalogue No. 53, released for distribution by Mechanical Air Controls, Inc., 15311 W. 11 Mile Road, Detroit 37, Mich., deals with its complete line of air valves. Each is illustrated to show construction and method of operation.

Crouse-Hinds Company, Wolf and Seventh North Streets, Syracuse 10, N. Y., has issued a bulletin about its new EV Series of explosion-proof and weather-resistant lighting fixtures. In addition to describing their components, it gives performance data and explains methods of installation and relamping. Ask for Bulletin Sec. K.

In its new edition of *Cutting Production Costs with Electronic Controls*, Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass., has compiled 46 case histories that show how standard packaged electronic controls have solved weighing, counting, measuring, timing and cycling problems. The book will be mailed free of charge.

Adhesives, Coatings and Sealers is the title of a bulletin prepared by Adhesives & Coatings Division, Minnesota Mining & Manufacturing Company, 423 Piquette Avenue, Detroit 2, Mich., to serve users as a guide. It lists the firm's most important of these products and will enable purchasers to select the ones best suited for specific needs.

Flodar Corporation, 1325 E. 45th Street, Cleveland 3, Ohio, has released a 28-page illustrated catalogue—No. 553—covering its complete line of high-pressure tube and pipe fittings. It contains information helpful in bending and in selecting tubing for specific applications, as well as instructions on how to make perfect joints.

The Louis Allis Company, Milwaukee 7, Wis., is offering a new bulletin covering its line of hollow- and solid-shaft vertical pump motors, together with the various types of enclosures available. Structural details of the units and many industrial uses are illustrated. Copy may be obtained from any Louis Allis district office or distributor.

In a new 24-page booklet The Sheffield Corporation, Dayton 1, Ohio, illustrates and describes its gauging cartridges or heads that may be used in conjunction with column- and dial-type Precisionaire and other makes of air gauges. Their gauging, tooling and fixturing applications, also in heretofore inaccessible places, are numerous.

Micro-Klean filters for liquid applications and a new graded-density wool-fiber cartridge are described in a 12-page bulletin, No. MK-0553, obtainable from Cuno Engineering Corporation, Meriden, Conn. Applications, case histories and a selector chart are included and, especially for engineers, viscosity conversion tables, hydraulic formulae, and an inch-micron conversion chart for standard screen.

The right paving breaker for every job is the theme of a new catalogue issued by Ingersoll-Rand Company. It contains pictures and a description of each machine, and a typical cross-sectional view shows all the important structural and design features of the series. Two pages of the 8-page bulletin are given over to available tools and accessories. For Form 4127 write to Ingersoll-Rand Company, Department RD, 11 Broadway, New York 4, N. Y., or any of its branch offices.

Sauerman
CRESCENT SCRAPERS

dig, haul and place more yardage faster—at lower cost!

Reduce difficult dig-haul-piling jobs to a simple, single operation with a Sauerman Crescent Scraper. Sizes range from ¼ to 15 cu. yds, to cover the needs of material handling jobs . . . large or small.

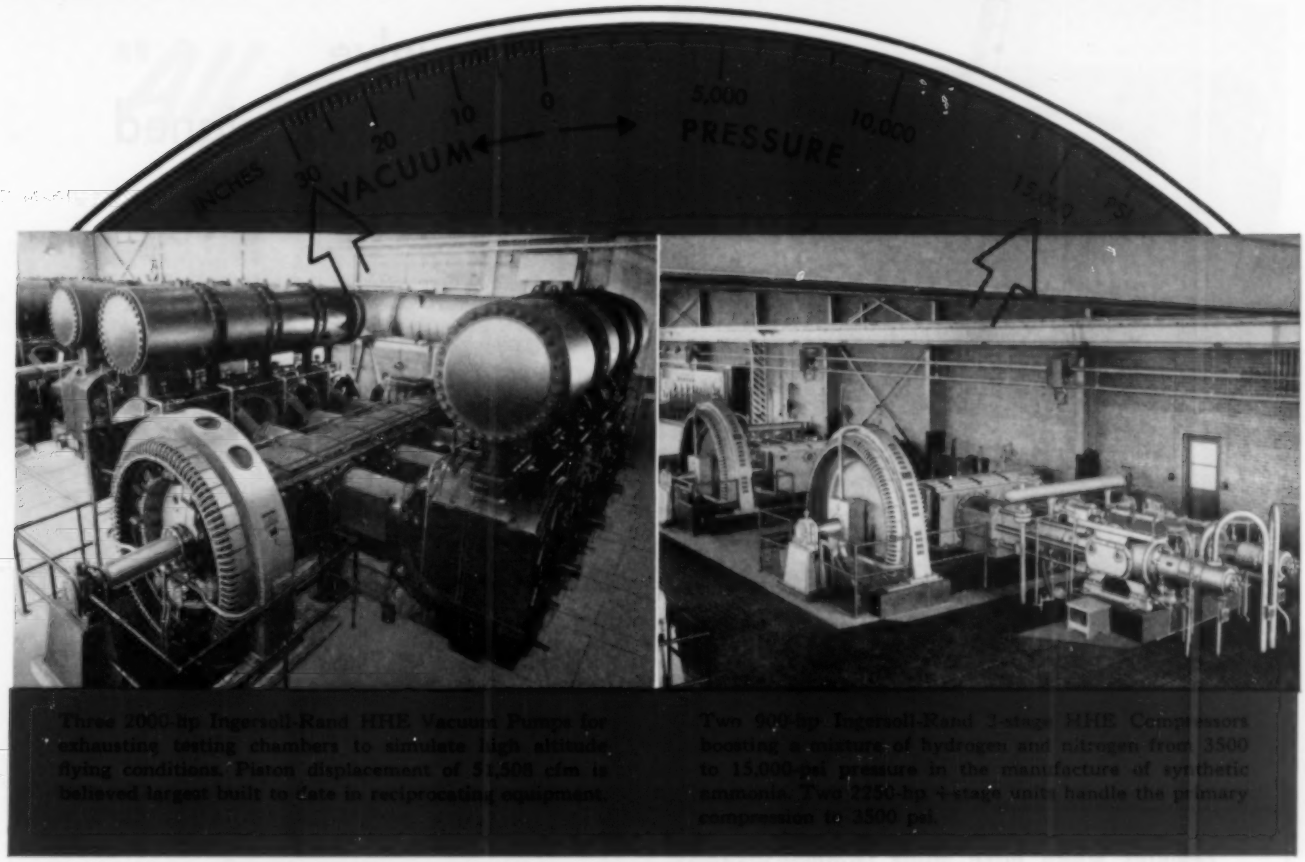
The Crescent, with rugged toothed-blade, penetrates the hardest material with plowshare ease. The unique bottomless scraper gathers a full load on the forward pull and hauls at ground level to the discharge point for an instantaneous, clean dump. A single operator situated in a safe, comfortable cab overlooking the work area, automatically controls all the digging, hauling and dumping operations.

Sauerman Scrapers are reasonable in first cost, simple and economical to maintain. Engineered to combine sturdy construction and wear-resistant lightweight metals, the Sauerman Crescent Scraper gives you small power consumption—diesel, gasoline or electric—compared to tonnages handled. Scrapers installed more than twenty-five years ago are still giving trouble-free service and are considered as good as new by their owners.

Write today for Catalog J for full information about the Crescent Scraper. Sauerman Bros., Inc., 548 S. Clinton St., Chicago 7, Ill.

SAUERMAN BROS., INC.
EARTHMOVING EQUIPMENT SINCE 1909

any pressure or vacuum you want–



Three 2000-hp Ingersoll-Rand HHE Vacuum Pumps for exhausting testing chambers to simulate high altitude flying conditions. Piston displacement of 51,500 cfm is believed largest built to date in reciprocating equipment.

Two 600-hp Ingersoll-Rand 2-stage HHE Compressors boosting a mixture of hydrogen and nitrogen from 3500 to 15,000-psi pressure in the manufacture of synthetic ammonia. Two 2250-hp 4-stage units handle the primary compression to 3500 psi.

from high vacuums to 15,000 psi pressure

Ingersoll-Rand Compressors meet industry's exacting needs with traditional I-R economy, dependability and low maintenance.

When a southern chemical corporation wanted to compress nitrogen and hydrogen to 15,000 psi in the production of synthetic ammonia, Ingersoll-Rand compressors were chosen for the job. When the aircraft industry needed big vacuum pumps to exhaust testing chambers in order to simulate high altitude flying conditions, again Ingersoll-Rand equipment was selected.

The installations pictured here are typical of the wide range of specialized services that I-R compressors are performing.

If you have a problem involving the compression or evacuation of air or gases, remember that for scores of years Ingersoll-Rand has been designing and building reciprocating, centrifugal, and steam-jet equipment—and combinations of these—to meet the most exacting requirements in all kinds of industries. Your I-R representative is well qualified to give you expert assistance, no matter what the gas, pressure, or process.

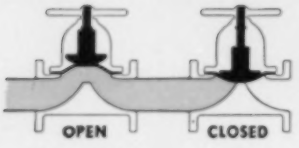
Ingersoll-Rand

833-1 11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • PUMPS • AIR AND ELECTRICAL TOOLS • VACUUM EQUIPMENT • ROCK DRILLS • CONDENSERS • GAS AND DIESEL ENGINES

The valve originally designed to eliminate

COMPRESSED AIR LEAKS



Features which have made Grinnell-Saunders Diaphragm Valves the specified valve in many different industries:

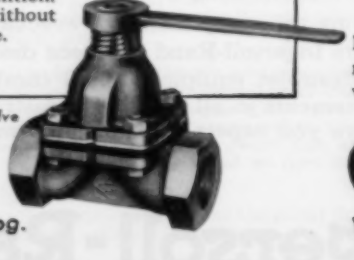
Streamlined flow. Smooth, streamlined passage, without pockets, prevents trapping of solids. Frictional resistance is at a minimum — regardless of direction of fluid flow. No disc holder in fluid stream.

Leak-tight closure against grit, scale, suspended solids. The resilient diaphragm, plus the large area of contact, gives leak-tight closure against pressure or vacuum.

Working parts absolutely isolated from fluid. Diaphragm completely seals off working parts from fluid in the line. No sticking, clogging or corroding of working parts. Valve lubricant cannot contaminate fluids.

Body, lining and diaphragm materials to meet service condition. Bodies stocked in cast iron, malleable iron, stainless steel, bronze and aluminum; other materials on special orders. Valve bodies lined with lead, glass, natural rubber or neoprene. Diaphragm materials of natural rubber or synthetics.

Minimum maintenance. No refacing or reseating is required. No packing glands to demand attention. New diaphragm can be inserted without removing valve body from the line.



Quick Operating Valve

Write for Grinnell-Saunders Diaphragm Valve Catalog.

A single 1/32-inch leak in an air valve can waste, in one month, the full cost of a Grinnell-Saunders Diaphragm Valve. In fact, that's why Grinnell-Saunders Diaphragm Valves were designed . . . to eliminate costly air leaks. Even when scale in the line becomes lodged on the valve weir, Grinnell-Saunders Valves give positive, air-tight closure.

The operating principle is simple. A rubber diaphragm, seating on metal, makes possible an absolute seal. At the same time, because working parts are wholly isolated, no packing glands are necessary, and stem leaks are impossible.

Successful on compressed air lines, it was only a matter of time before Grinnell-Saunders Diaphragm Valves were in demand for other type installations . . . handling materials as diversified as corrosive fluids, gases, beverages, foods, suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors.

Grinnell-Saunders Diaphragm Valves can be had with body, lining and diaphragm materials to meet different service conditions. Assign your next valve problem to Grinnell.

GRINNELL

WHENEVER PIPING IS INVOLVED

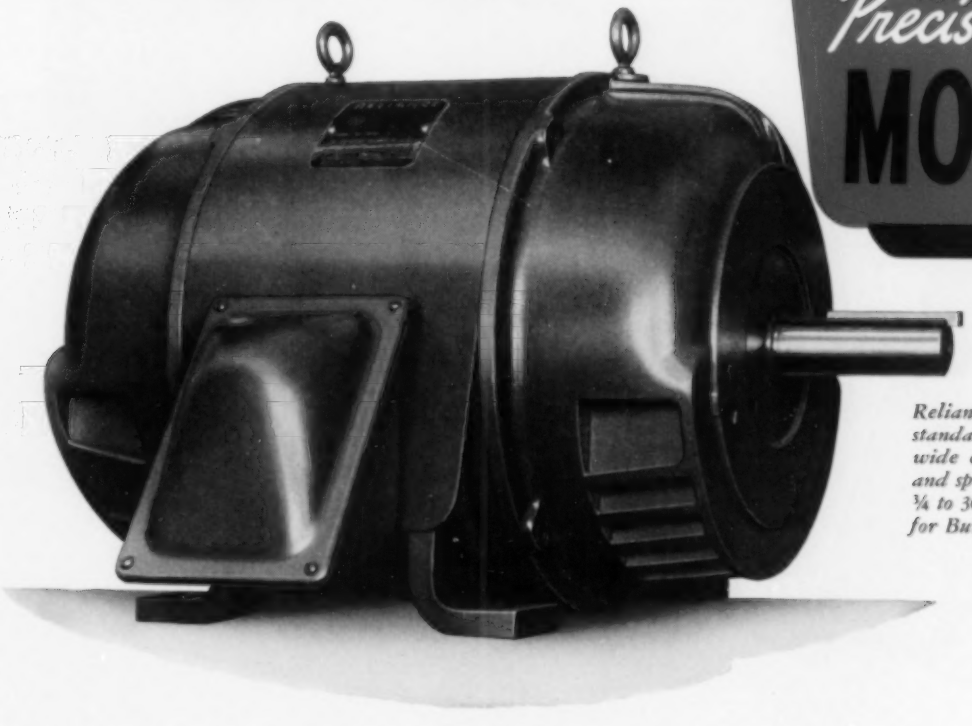
Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

FOR COMPRESSOR SERVICE...

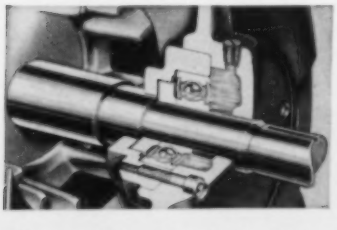
"All motors are NOT alike!"

RELIANCE *Precision-Built* **MOTORS**



Reliance Splashproof Motor. All other standard enclosures available, with wide choice of mechanical designs, and special mountings. Ratings from ¾ to 300 hp. Get the full story—ask for Bulletin B-2101.

- ☆ Low starting currents... high starting torque ...liberal ratings
- ☆ Smooth acceleration ... quiet operation
- ☆ Tough, vibration-proof Reli-X insulation



... AND THE BEST PRE-LUBRICATED BEARING DESIGN

The Reliance pre-lubricated bearing provides *four times more operating hours without re-lubrication* than any other bearing used in motors today. And—whatever your lubrication schedule—*you just can't grease 'em wrong!* To get the complete "inside story" on motor bearings, write today for Bulletin B-2201. It contains hard facts on the advantages of the Reliance pre-lubricated bearing design, with cutaway view, cross-section diagram, comparison chart, and statements by bearing manufacturers. B-1458C

RELIANCE ELECTRIC AND ENGINEERING CO.

1118 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

Electric Eimco 12E

Another first in underground loading equipment by Eimco. Here, for the first time, is a small mechanical loader with electric motors and controls as rugged as the air powered models that have been standard mine equipment in all mining districts of the world for many years.

The 12E gives the same high performance speeds, the same efficient operation, the same ease and convenience for the man on the machine as previously known on air-powered models.

This machine is presently available for AC operation in all voltage ranges. Motors and controls are totally enclosed, sealed against all outside contaminants. Machines can be supplied for permissible explosion proof specifications when required.

Great care has been exercised in the design and construction of these machines in order that no function of the machine or no movement of the operator would be different than that of the air powered equipment.

Write for more information.

EIMCO 1400

THE EIMCO CORPORATION

The World's Largest Manufacturers of Underground Rock Loading Machines

EXECUTIVE OFFICES AND FACTORIES – SALT LAKE CITY 10, UTAH, U. S. A.

BRANCH SALES AND SERVICE OFFICES:

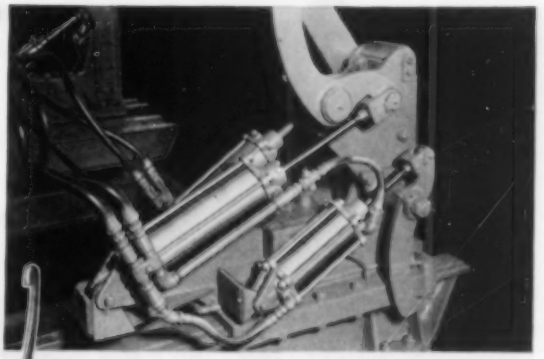
NEW YORK, 51-52 SOUTH STREET • CHICAGO, 3319 SOUTH WALLACE STREET
BIRMINGHAM, ALA., 3140 FAYETTE AVE • DULUTH, MINN., 216 E. SUPERIOR ST.
EL PASO, TEXAS, MILLS BUILDING • BERKELEY, CALIF., 637 CEDAR STREET
KELLOGG, IDAHO, 307 DIVISION ST. • LONDON W. 1, ENGLAND, 190 PICCADILLY

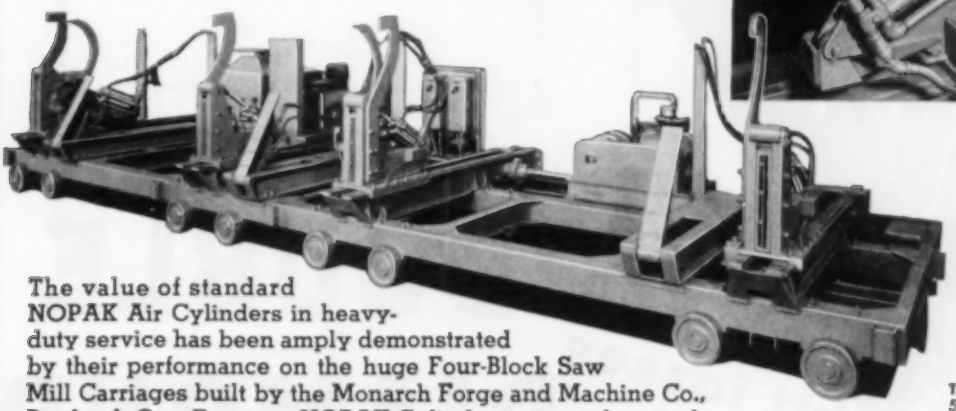
IN FRANCE: SOCIETE EIMCO, PARIS, FRANCE
IN ENGLAND: EIMCO (GREAT BRITAIN) LTD., LEEDS 12, ENGLAND
IN ITALY: EIMCO ITALIA, S.P.A., MILAN, ITALY

You Can't Beat An Eimco

"Double Hook Dogs"

are Powered by NOPAK Cylinders on Monarch Four-Block Saw Mill Carriages





Close-up view of "Double Hook Dog" assembly shows how 3 NOPAK Model "E" Cylinders of different diameters and stroke lengths are employed to operate this mechanism. There are 4 of these "Double Hook Dogs" on each carriage.

The value of standard NOPAK Air Cylinders in heavy-duty service has been amply demonstrated by their performance on the huge Four-Block Saw Mill Carriages built by the Monarch Forge and Machine Co., Portland, Ore. Fourteen NOPAK Cylinders are used on each of these carriages which are extremely rugged in construction, and designed especially for the large western mills which utilize old growth fir and redwood logs. Monarch continues to specify NOPAK Cylinders because they really stand up under the rugged operating conditions to which they are subjected day after day, throughout the year.

GALLAND-HENNING NOPAK DIVISION, 2759 S. 31st St., Milwaukee 46, Wis.

Pacific Coast Representatives

J. M. O'BRIEN
32 North Holman Street
Portland 11, Ore.

E. C. GRIFFIN CO.
524½ First Avenue South
Seattle 4, Wash.

TRANSMISSION ENGINEERING CO.
53 Stevenson St., San Francisco 5, Calif.

THE WILLARD ENGINEERING CO.
218 W. 28th St., Los Angeles 7, Calif.

NOPAK

VALVES AND CYLINDERS

DESIGNED for AIR and HYDRAULIC SERVICE

A 7659-½-H

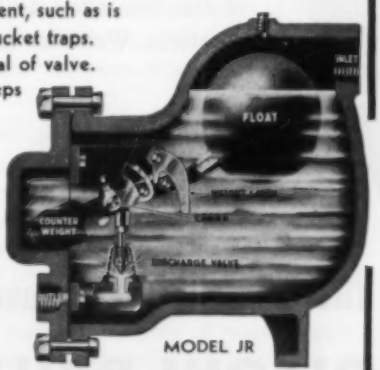
Solve Sludge Problem with Nicholson's

New AIR TRAPS

With the introduction of an exclusive new oil-eliminating feature that prevents build-up of scum and sludge, Nicholson air traps now enable you to enjoy the advantages of the positive intermittent action of a float-operated air trap without the common problem of oil congealing on the mechanism and impeding or stopping its action. Other features of Nicholson air traps:

1) No air-wasting vent, such as is in all inverted bucket traps.
2) Positive water seal of valve.
3) Large orifice keeps valve clean, preventing blow-through. Three types; pressures to 1500 lbs. For details send for

CATALOG 953



180 Oregon St., Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

TWO HANDY REFERENCE BOOKS

For

The Engineer, The Superintendent, The Operating Man

Cameron Pump Operator's Data.....$2.00
Cameron Hydraulic Data.....$300

or

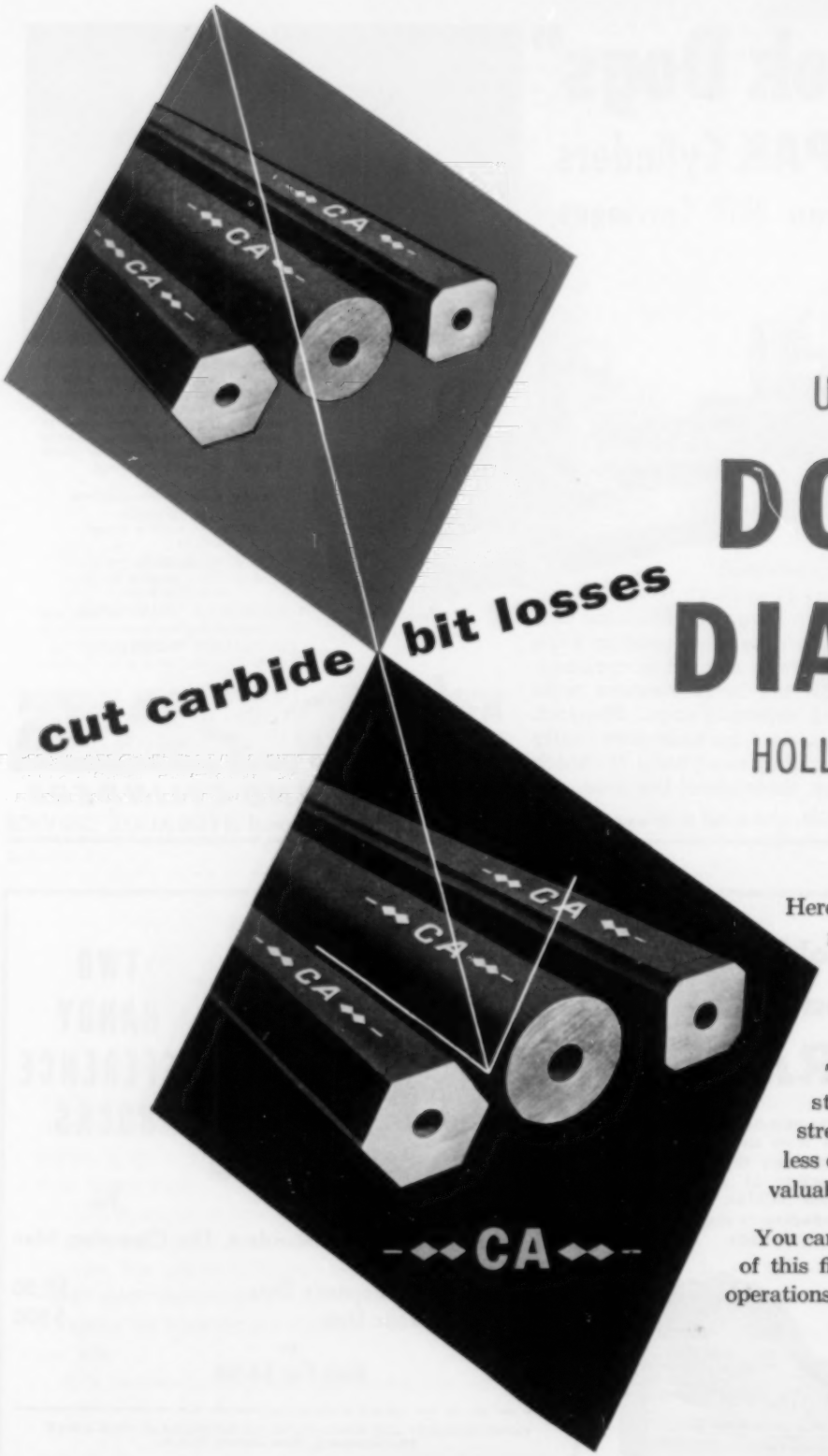
Both For $4.50.

COMPRESSED AIR MAGAZINE, 942 MEMORIAL PARKWAY
Phillipsburg, New Jersey, U.S.A.

PLEASE SEND ME:

- ☐ Cameron Pump Operator's Data and Cameron Hydraulic Data. Both Books.....$4.50
- ☐ Cameron Pump Operator's Data.....$2.00
- ☐ Cameron Hydraulic Data.....$3.00
- ☐ Enclosed (Money Order) (Check) for $.....
- ☐ Send Books C.O.D. (U.S.A. only)

Name.....
Company.....
Street and No.....
City.....State.....Country.....



cut carbide bit losses

USE CRUCIBLE

DOUBLE DIAMOND

HOLLOW DRILL RODS

Here's the finest, toughest hollow drill rod made. Crucible DOUBLE DIAMOND is made to tool steel specifications by the nation's leading producer of tool steels.

That's why it has greater fatigue strength . . . and greater fatigue strength means lower drilling costs — less down time and fewer losses of those valuable tungsten, carbide bits.

You can't afford to overlook the advantages of this fine alloy drill rod in your drilling operations. Write for full details.

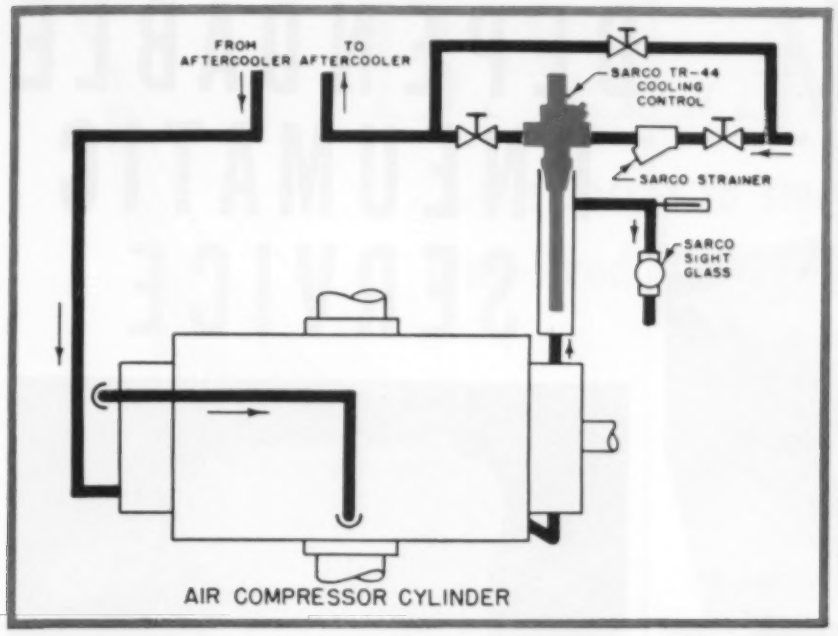
CRUCIBLE first name in special purpose steels

53 years of Fine steelmaking

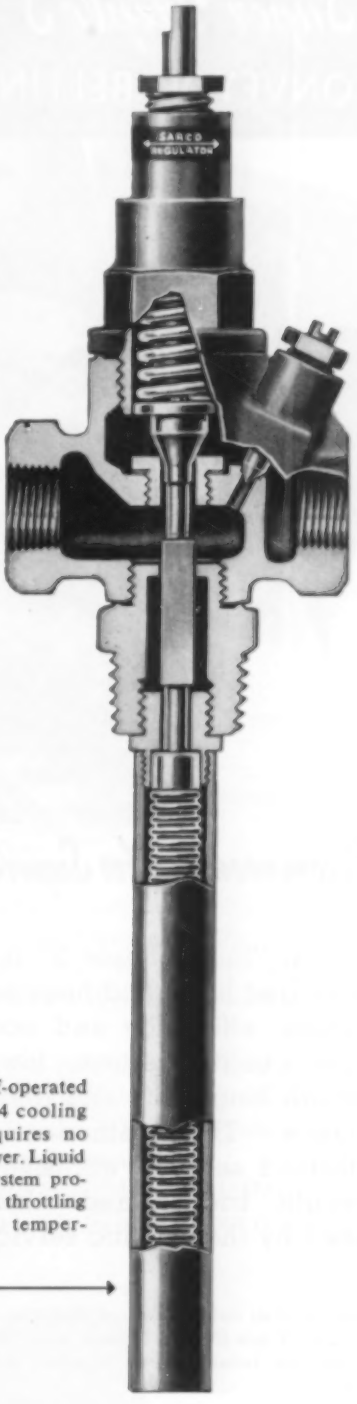
HOLLOW DRILL RODS

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS



Sarco Cooling Control guards against dangerous over and under cooling.



Compressors

work better, last longer, cost less to run

with SARCO

COOLING CONTROLS

YOU have to keep your eye on a lot of things to get top efficiency from compressed air systems – and one of the most important is *cooling*.

For example, overcooling – usually a result of manual control – causes condensation on cylinder walls which destroys lubricant and increases wear. In addition, it wastes water.

If you're undercooling, you're cutting down on compressor capacity – and you're taking chances of damaging cylinders, pistons, valves and seats.

It's a lot easier – and also safer and more economical – to let dependable Sarco self-operated temperature controls take over. They insure optimum cooling effect with minimum water consumption regardless of load variation, changes in pressure and temperature of water supply. *You get protection for compressors with maximum efficiency at minimum cost.*

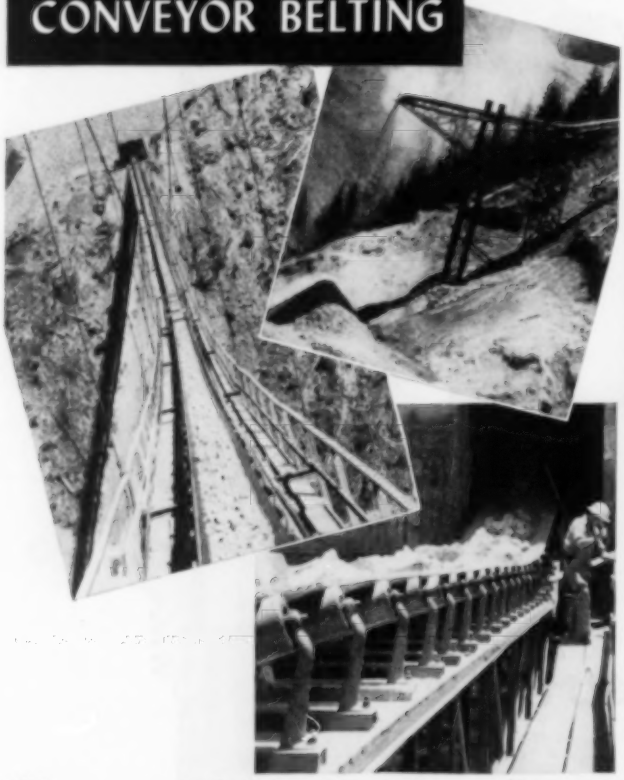
Send for Bulletin No. 520-A "Is Your Air Compressor Capacity Effective?" Sarco Company, Inc., Empire State Building, New York 1, N. Y. Representatives in principal cities.

Simple, self-operated Sarco TR-44 cooling control requires no auxiliary power. Liquid expansion system provides perfect throttling throughout temperature range.

SARCO

COOLING CONTROLS • DRAIN TRAPS • STRAINERS
THERMOSTATS • PRESSURE SWITCHES

GOODALL
Super Triple S
CONVEYOR BELTING



Recommended for Super-Severe Service

Goodall "Super-Triple S" is built to handle the longest hauls and heaviest loads with unequalled efficiency and economy. Its reliable quality assures low ultimate cost through longer life and freedom from maintenance. The weather-resistant cover will withstand severest abrasive wear. Tensile strength, friction and other details determined by the specific service requirements.

Other Goodall Belting for less strenuous service includes "Triple-S", "La Crosse" and "Goodall" brands, the latter with oil-resistant Neoprene covers.

Contact Our Nearest Branch for Details and Prices

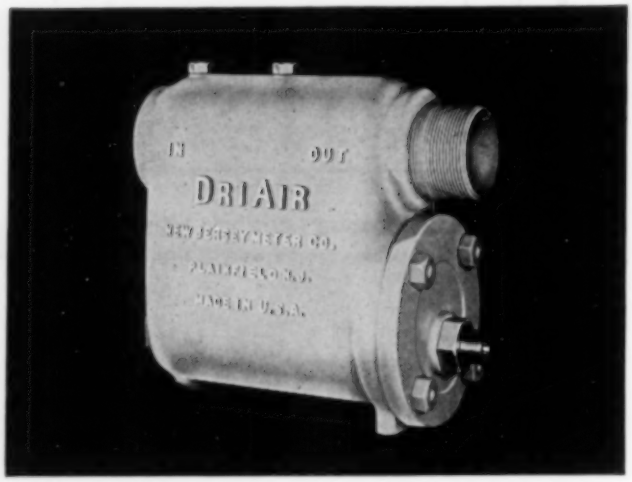
GOODALL RUBBER COMPANY

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches Philadelphia • New York • Boston • Pittsburgh • Indianapolis • Chicago • Detroit • St. Paul
Los Angeles • San Francisco • Seattle • Spokane • Portland • Salt Lake City • Denver
Houston • Goodall Rubber Company of Canada, Ltd., Toronto • Distributors in Other Principal Cities

Est. 1870

DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected.

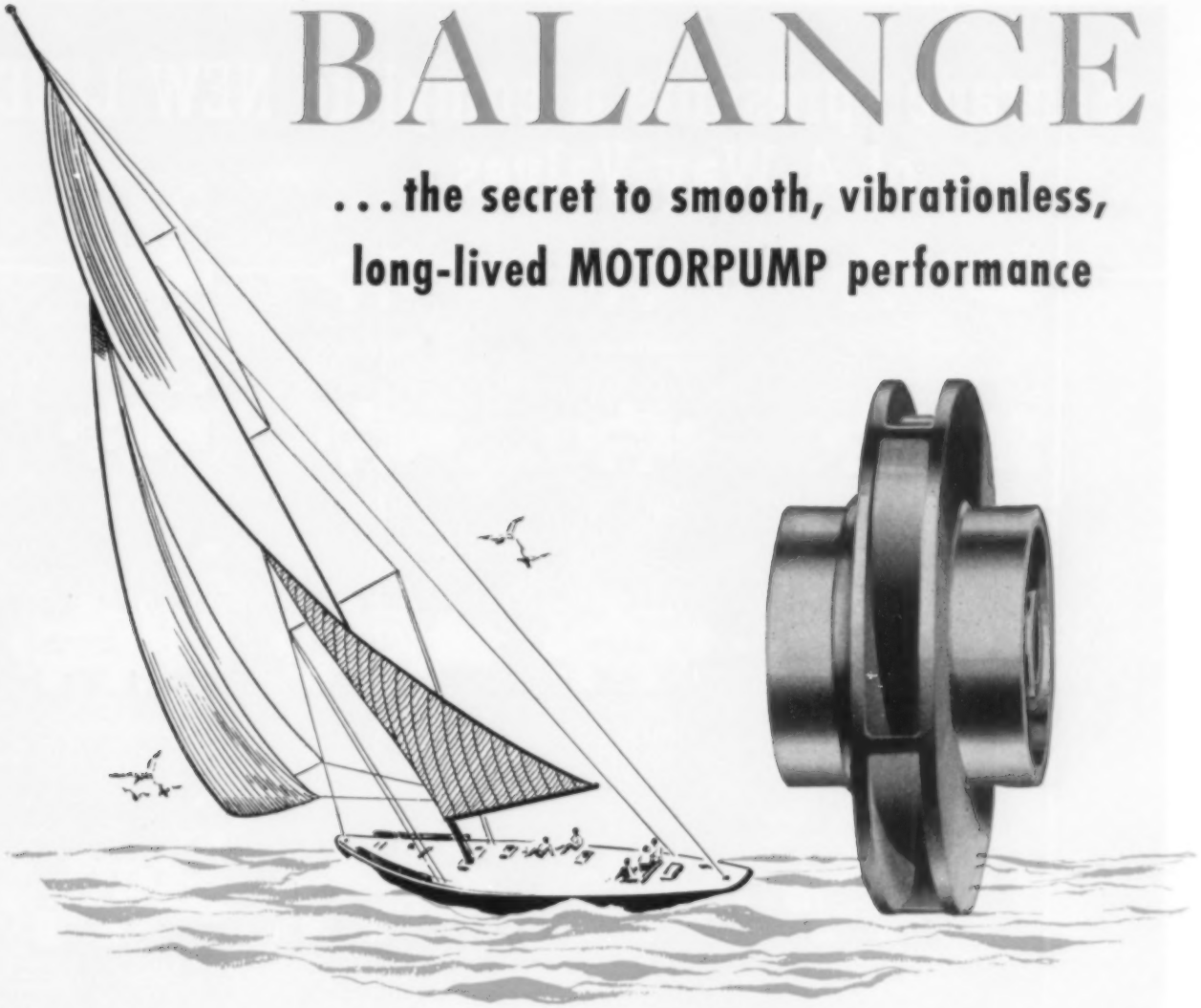
DRIAIR speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

BALANCE

. . . the secret to smooth, vibrationless, long-lived MOTORPUMP performance



MECHANICAL BALANCE

Is achieved by an even distribution of metal in the impeller, which keeps the radial load on the bearings and shaft at a minimum. The impeller of I-R Motorpumps is subject to critical balance tests to insure smoothness, quietness, freedom of vibration. These tests are your assurance of efficient pump performance, long trouble-free operation, a minimum of wear on close running parts.

HYDRAULIC BALANCE

In the Motorpump contributes materially to long-life and low maintenance. The engineered use of a balancing orifice stabilizes the forces acting axially on the impeller. Hydraulic balance, thus achieved, lowers the thrust load on the bearings and increases the life of the pump. It also keeps stuffing-box pressure low, which lengthens packing or seal life and reduces maintenance.

BALANCE is a law of nature which creates orderliness amid strong opposing forces. Without it there can only be swift moving forces that lead to destruction. That's why *balance* is always uppermost in the minds of I-R designers and engineers.

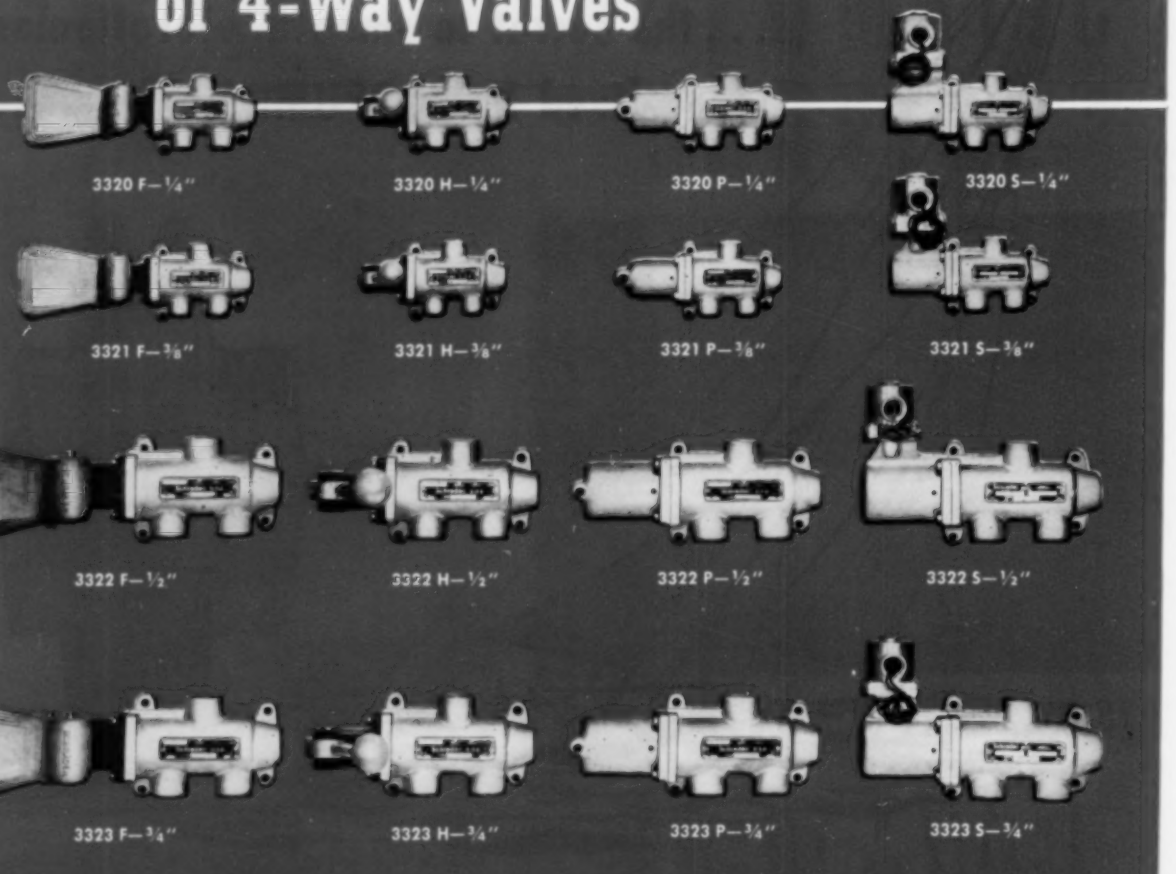
Balance . . . careful design . . . these hold the secret to volume flow through *small* units. This explains why Ingersoll-Rand Motorpumps are so efficient . . . why I-R Motorpumps so often outperform other pumps of the same size.

Ingersoll-Rand Motorpumps are available FOR IMMEDIATE SHIPMENT in sizes from 1/4 to 50 hp. Call our nearest branch office or write direct.

Ingersoll-Rand

975-9 **11 Broadway, New York 4, N. Y.**

Schrader presents a complete NEW LINE of 4-Way Valves



FOOT OPERATED
Feature light foot action—can be operated all day without fatigue.

HAND OPERATED
Feature light snap on and off action for fast, accurate control.

PILOT OPERATED
Especially desirable for remote control applications.

SOLENOID OPERATED
Available for 110, 220 or 440 volt AC.

These new Schrader Valves are primarily designed for operation of Double-Acting Cylinders. Their simplified design and construction of long-lasting metals assure reliable, long service with minimum maintenance. Can be serviced without removal from airlines. Available in the popular sizes ¼, ⅜, ½ and ¾ N.P.T., they are produced for flow capacities from 160 to 425 cubic feet of free air per minute at 100 psi inlet pressure. They demonstrate again Schrader's leadership in compressed air equipment. For full details, write—or fill out and mail the coupon below.

Schrader
REG. U. S. PAT. OFF.

products
control the air

Air Cylinders • Operating Valves • Press & Shear Controls • Air Ejection Sets • Blow Guns • Air Line Couplers • Air Hose & Fittings • Hose Reels • Pressure Regulators & Oilers • Air Strainers • Hydraulic Gauges • Uniflare Tube Fittings

Mail This Coupon Today

A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
478 Vanderbilt Avenue, Brooklyn 38, N. Y., Dept. W-4A

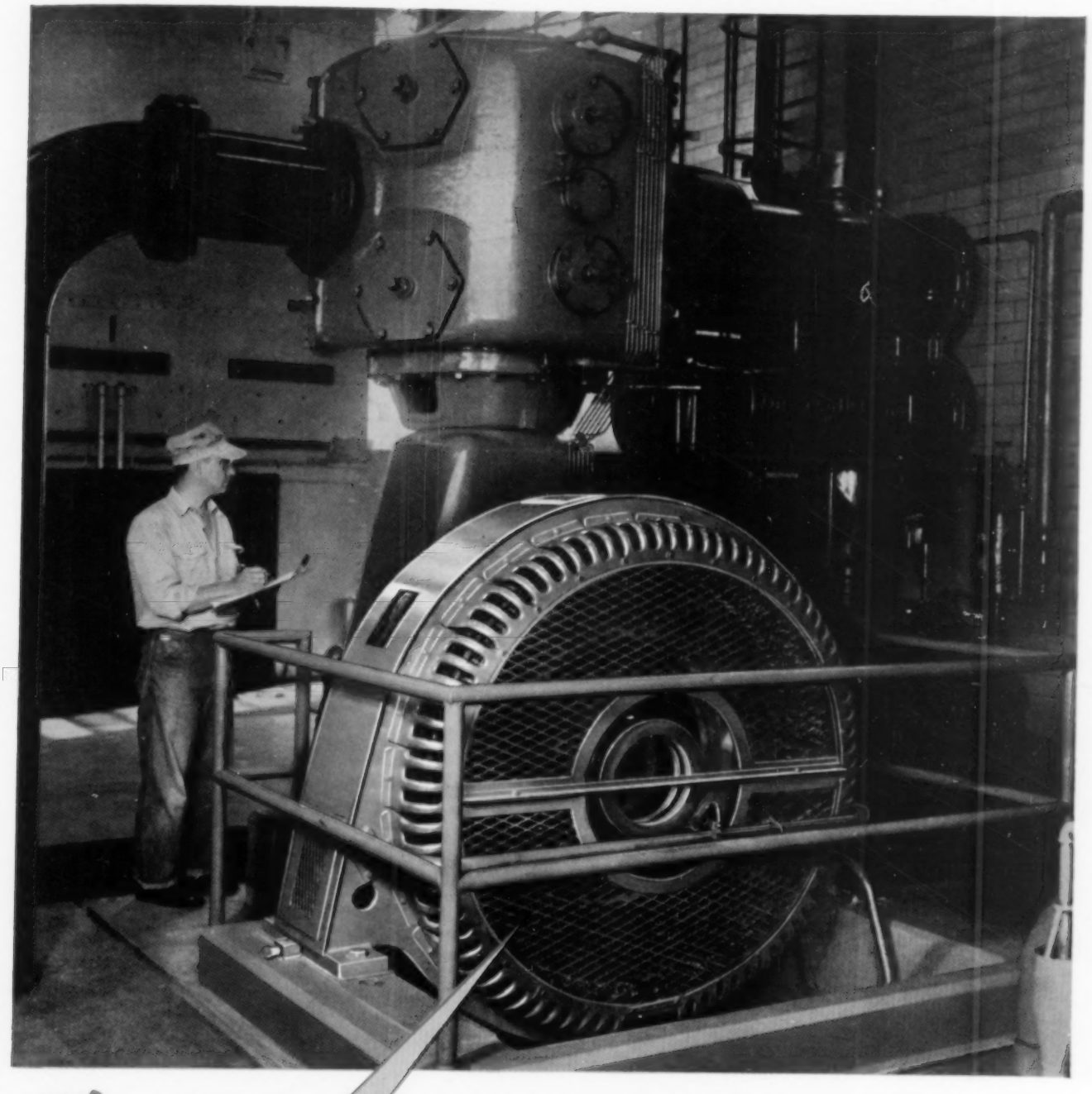
Please send me full details on your new line of 4-Way Valves.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____



They're tops on compressor drives

ELLIOTT synchronous MOTORS

THE PICTURE SHOWS an Elliott 450-hp, 327-rpm synchronous motor driving an Ingersoll-Rand air compressor in a Detroit area auto plant.

Elliott synchronous motors can be supplied for any type of reciprocating compressor. They are "custom-built" for the compressors they drive, with quality performance and low maintenance insured by such refinements as mica ground insulation at 2300 volts or higher, lugs on the sole-plate to permit horizontal adjustment of air gap, and holes provided for lifting the stator.

For full data, phone your local Elliott representative or write Elliott Company, Ridgway, Pa.

Elliott FABRI-STEEL MOTORS AND GENERATORS

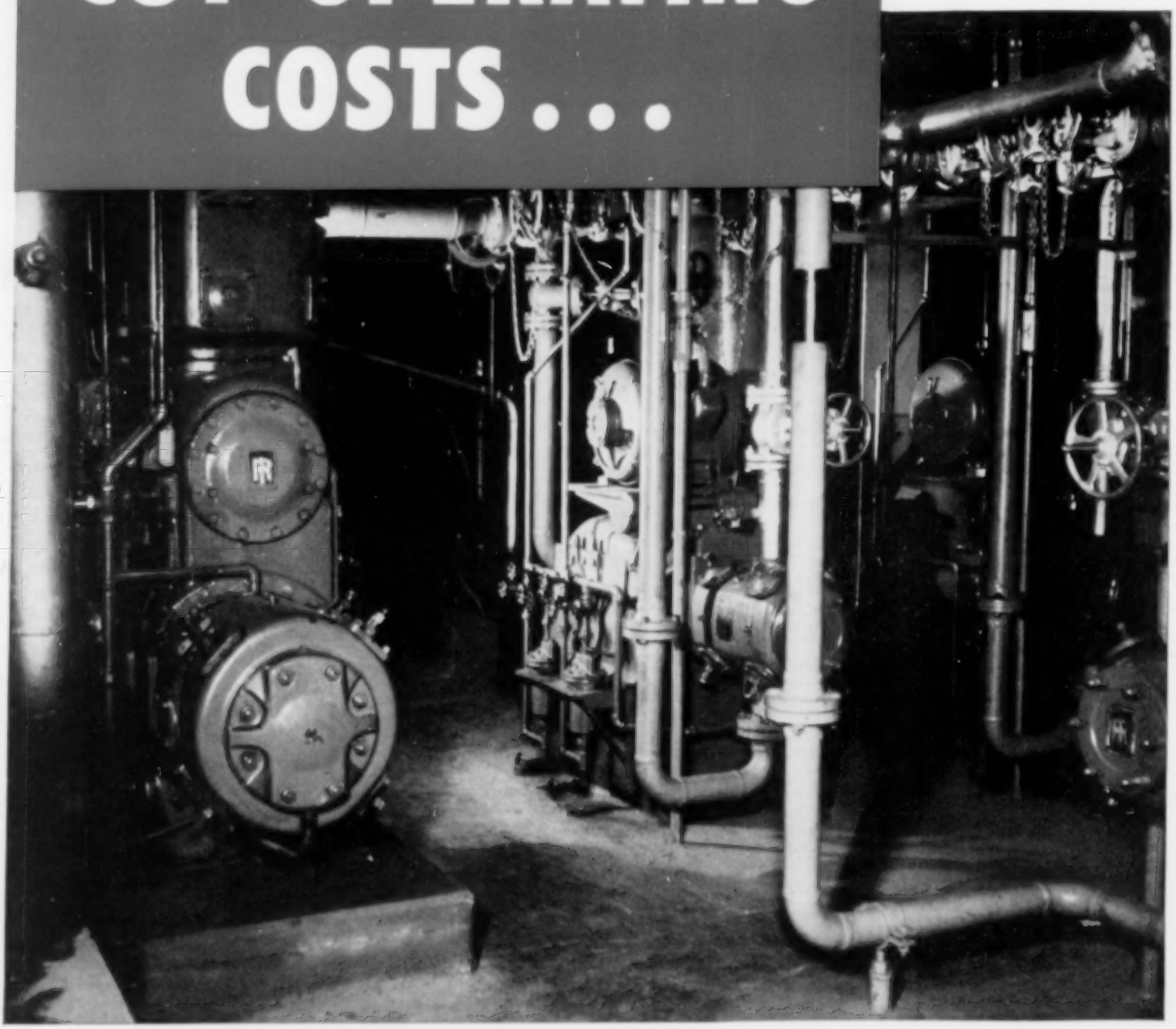
R3-14

ELLIOTT Company

RIDGWAY DIVISION

FOR MOTORS 1-200 HP: CROCKER WHEELER DIV. AMPERE, N. J.

CUT OPERATING COSTS . . .



FOR YOUR COMPRESSORS, economical operation depends on effective lubrication. But, since *no one* oil can efficiently handle *all* the various conditions under which compressors operate, you must use the oil that's *exactly suited* to *your* compressors and operating conditions.

Texaco has this exactly-right oil for you because Texaco makes *a complete line* of air compressor oils. There is a Texaco air compressor oil to assure clean, dependable, low-cost operation for every type and size of compressor, under every operating condition.

A Texaco Lubrication Engineer will gladly help you select the proper one. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Air Compressor Oils

FOR ALL OPERATING CONDITIONS